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ABSTRACT

This report presents the findings of an evaluative study of the current status of engineering education for minority students at the collegiate and pre-collegiate levels in the United States. It is based on a survey of 50 existing programs and a review of the professional and research literature in this field. The major findings of the analysis indicate that engineering programs for minorities have been relatively effective in increasing the number of Black and Hispanic persons who enter the profession. The number of minority graduates from these programs has increased tenfold in the last 15 years. However, minorities continue to be underrepresented in engineering, particularly at leadership levels. Engineering draws disproportionately from a limited pool of minority talent that is identified at the high school level, and not enough organized effort has been made to develop academic talent in less able academic learners. To expand the minority academic talent pool, it may be necessary to increase students' early-life exposure to mathematics and science and to increase remedial instruction. Engineering programs provide a wide variety of counseling, financial, and tutoring services, but there is considerable unevenness in the quality of conceptualization, design and delivery of programs. Research on effective programs is analyzed and suggestions for improving interventions are offered, and implications for research and development are discussed. Appendices include brief descriptions of responding programs and a list of members of the advisory panel to the study. (KH)

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By

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October 1986

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A Descriptive Analysis of Programs and Trends in Engineering Education for Ethnic Minority Students

Executive Summary of a Report by

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This report is concerned with the current status of engineering education for minority students at the collegiate and pre-collegiate levels in the U. S. A. It is based upon a survey and review of fifty existing programs and a review of the professional and research literature in this field. The major findings are:

1. The engineering field has surpassed other professions in effectively increasing minority involvement. Specifically, the number of minority graduates from these programs has shown a ten-fold increase in the last fifteen years.
2. Despite these gains, minorities continue to be underrepresented in engineering and the engineering sciences, particularly at leadership levels. Furthermore, there is almost no organized effort to attack the problem of

engineering and science literacy in the general population, as a prerequisite to the development of interest and potential for the study of engineering in an expanded pool of minority students.

3. Engineering draws disproportionately from a still limited pool of minority talent that is identified at the high school and, to a lesser extent, intermediate school levels. In fact, the field currently attracts about 50% of all minority students identified as academically very well prepared for college.

4. This emphasis on the discovery of talent or identification of persons who show that they have well-developed academic abilities may be dysfunctional. It is understandable, since we know more about teaching well-prepared learners than we know about developing academic talent in less able academic learners. Yet, despite this emphasis on recruitment of the very well prepared, many of the programs studied do admit students who need considerable academic help if they are to flourish in rigorous courses of study rooted in mathematics and the sciences. It is here that the overemphasis on discovery is dysfunctional. These marginal students need our most resourceful developmental interventions but at present time their success in engineering programs is uneven. There is a second aspect to the possible inappropriateness of overemphasizing talent discovery. Since the number of academically able minority students graduating from high school each year is still relatively limited, it does not make sense that all of our institutions

compete for that same pool without first determining whether the pool can be expanded by improving educational opportunities for students when they are much younger (e. g., ages six to twelve). Indeed, unless the pool can be expanded significantly over a period of years, continued growth of minority representation in engineering and the related professions probably will be increasingly difficult to achieve.

5. The problem of pool expansion is threefold. It involves:

   a. expanding the pool of persons with leadership potential and enhancing their developmental opportunities;

   b. expanding the pool of persons with potential and opportunity for participation in the profession;

   c. increasing the level of engineering and science literacy in the minority population.

6. Evidence from professional experience, developmental theory and educational research is converging to support several conclusions relating to the facilitation of student academic development and academic talent pool expansion. Among the more salient are the following:

   a. Exposure early in the life of the child (ages 5 or 6 to 12 years) to rewarding hands-on experiences in mathematics, science and technology with ample opportunities for exploring, discovering, and questioning relationships between concepts and materials.

   b. Early and continually mediated learning experiences in which learners are guided in their identification of salient and distinguishing features, lawful relationships, taxonomic indicators, and other aids to information processing, which also serve to maintain a balance between challenge and frustration in learning.

   c. As obvious as it may sound, exposure to relevant experiential and theoretical course work is

increasingly recognized as an essential in the facilitation of student academic development. Such exposure is certainly not a sufficient condition, but we now recognize that it is an essential condition which is not experienced by large numbers of minority students. We are also increasingly aware of how difficult it is to assume that schools are able to provide the coursework in an appropriate way to minority students.

d. Incidental or directed learning experiences designed to enhance cognitive competence, such as problem solving, critical thinking, meta-cognition, knowledge acquisition strategies, and the executive management of mental processes.

e. Targeted instruction and remediation where teaching and tutoring are informed by psychoeducational assessment data which enable the customization of learning experiences to meet the specific as well as generic needs of learners.

f. Socialization to the demands and rewards of academic and professional life appears to be essential to the development of students whose natural environments have not provided such socialization experiences. Young people who are the first generation of their family to seriously pursue academic work and higher education have had fewer opportunities to learn the demands and routines of rigorous academic work.

7. Engineering enjoys a success rate comparable to other areas of collegiate study in terms of the education of reasonably well-prepared high school and college students. However, we estimate that slightly less than 50% of those who enter a course of study complete it. This is wasteful, considering the talent pool from which engineering draws, but it is par for the course. The problem is to reduce this attrition, even while we improve our capacity to serve a less-well-prepared population of minority students.

8. Typical programs surveyed for this study include activities such as: counselling, pre-college orientation and preparation, science and mathematics instruction, cognitive

development/problem-solving enrichment, tutorial programs, mentor/role models, financial aid and scholarships, remedial work, and study skills instruction. However, there is considerable unevenness in the quality of conceptualization, design and delivery of programs. Some programs reflect very clear conceptions of a view of the problem and an approach to solving it. Others lack such clear vision and appear to be opportunistic or faddish in their design. Few comprehensive, well-executed programs were identified.

9. Owing to the very limited amount of data that is collected on these programs, it is difficult to ascertain with precision how effective individual programs actually are, to compare several programs, or to assess improvement that several may have achieved over time. Indeed, one of the most pressing needs in this area is for better information systems.

10. Several interesting experiments in curriculum and teaching have been identified which show promise for enhancing student mastery of problem-solving, logical reasoning, math, and science, but these models are not in wide use.

11. Efforts of varying quality can be identified which are directed at psychosocial and personal adjustment and motivation. This area is recognized to be of crucial importance, and includes attention to: the presence of a critical mass of minority students, role models with whom minorities can identify, coping with intentional and unintentional racism, psychosocial support, and

socialization to academic and professional pursuits.

12. There is a relatively untapped new knowledge base and technology for pedagogy, drawn from the cognitive sciences, which shows interesting potential for meeting some of the academic development problems in this area. The application of this new knowledge and technology is lagging behind in engineering, as in education in general. Yet, the development of intellect and intellectual skills which may be fundamental to further expansion of the minority pool is at least promised in this new work.

13. There are potential conflicts between the mechanisms of expanded minority participation and the mechanisms of leadership development. The programs studied and the field in general have demonstrated that talent search, support services, and financial aid have served the purpose of increasing minority participation in engineering. It is not as clear that these strategies are sufficient to serve the equally important purpose of leadership development. In fact, the mechanisms may be in conflict with each other and thus reciprocally counterproductive. Leadership development, for example, may require enrichment intervention of a different order from that necessary for survival in the field. Leadership development may require that we concentrate on fewer students. It may mean that preparation for leadership careers in engineering requires that we intervene earlier and continue interventions long past graduation from the educational institution. It may require that factors in the profession and institutions

which employ engineers will have to be made less hostile to and more supportive of the advancement of new members for whom color, dominant language, and cultural styles may be different, even while they demonstrate excellence along traditional standards. Our studies so far have not enabled us to say with authority how to address intervention on these fronts. It is clear, however, that both the purposes of expanded participation and expanded leadership development must be served. The challenge is to improve our approach to both.

14. The report also includes recommendations for further research on the problems of increased minority participation in engineering education and careers in engineering.

15. Finally, our review of the minority engineering effort strongly suggests that those engaged in it enter a period of stock-taking. Fifteen years' hard work has resulted in a substantial increase in minority participation in engineering. Yet, further progress probably will become increasingly difficult if the pool of well-developed minority students does not begin to grow more rapidly. If this is true, what has the field learned that would be of most value programmatically in the short- to medium-term? How could this knowledge be more widely used? For the long-term, what new strategies and activities must be added? These are a few of the major questions that need to be addressed.

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PREFACE

The questions that now lay before the nearly fifteen-year old national effort to increase the numbers of Blacks, Hispanics (particularly Puerto Rican and Mexicans) and American Indians who graduate from engineering colleges are at its very heart.

There is no question that the original goal of a ten-fold increase in those numbers has been met. Neither can it be disputed that the many programs initiated at both precollege and college levels to serve the original goal have contributed greatly to its realization. No other profession can take pride in that order of achievement. The minorities-in-engineering effort remains one of the nation's finest examples of private sector initiative in pursuit of equity.

But the concommitant problems that were originally believed would yield in the process still remain, poorly understood and subject to inconsistency in definition. Yet they demand resolution and solution if this activity is to realize additional progress and its true potential for change.

Drawing upon extensive research and experience in remedial and compensatory education, the distinguished scholar Edmund W. Gordon and his associates present in the pages that follow a thoughtful overview of the current status of our efforts at Engineering Education for Minority Students. The report is comprehensive in its coverage of topics related to this activity. It presents a historical perspective, data concerning the numbers and academic characteristics of the pre-college minority pool as well as the numbers who have graduated from engineering colleges in recent years. It catalogues and comments upon the kinds and frequencies of components (e.g., tutoring, counseling, etc.) found in the over fifty programs responding to a survey, as well as those treatments that offer the hope of continued and increased rates of success but which appear to be underrepresented in programs so far.

Among the latter are techniques derived from recent findings in the behavioral and cognitive sciences as well as advances in the affective and psychosocial areas and in the broader arena of compensatory and remedial education. Synopses are presented of many such techniques and they will be particularly useful to readers as specific avenues for exploration.

Most important, in my opinion, however, is Dr. Gordon's discussion of the conceptual issues, many of which have provided over the years, sometimes tacitly, the effort's direction -- and, sometimes its lack of direction.

For one, there is the issue of what constitutes the overall and program-specific mission(s) and goals. Lack of agreement concerning them is a serious obstacle to effective planning, whether on a national or local scale. In 1973, it seemed reasonable to be guided by the beliefs that the nation had an unending need for engineers -- any kind -- and that "the surest route to leadership," was, as described by one of the early audio-visual presentations of the minorities-in-engineering activity, via the profession of engineering. Those precepts have so shifted and broadened over the past fifteen years, however, that what is operative now is a spectrum of missions comprising contradictionsthat are dysfunctional as basesnot only for planning but for evaluation as well. Not only has the mission shifted and broadened, but the pointsfrom which to measureprogrammatic success have shifted as well. In the same way that the mission has undeniably been affected by changes in the nation's attitudes and its human resources projections, so too, has the status of the target populations -- negatively according to most measures. Those downward shifts in social indicators for minorities should contribute to the desire to legitimize some of the operative program missions that, here-to-fore have seemed too ambitious, altruistic or far-afield. Of course, it will also be necessary to accept more openly the long-term nature of challenges and solutions, which include not only reaching larger numbers of students but also institutionalizing improved educational techniques and programs on their behalf.

Agreement on the reasons for such action may not be necessary. It may not matter whether we do so to achieve continued growth in the numbers of graduates and minority participants in engineering; or because a larger pool of participants is needed for a reasonable yield of "leaders"; or because it is the moral thing to do; or because it can contribute toward subverting some serious and otherwise probable social problems. If we simply act logically upon the conclusions presented in this report and begin to tackle the challenges of expansion into even more nontraditional and younger pools, this is likely to make evidence of success more difficult to come by even as it offers greater potential for progress. None the less, it is imperative that we address the issues raised because the broader mission is becoming more difficult to achieve and it is also more important.

Although there are many issues raised or implied in the following pages, I will select just one more for comment. Of the programs surveyed by questionnaire, there seem to be few evaluations from which to answer the kinds of questions that need answers now, such as the characteristics of the populations being served and their needs; the effectiveness of the components in place that address those needs. Dr. Gordon provides many suggestions for further research and evaluation. It may be that typical program size and budget preclude evaluation in depth but the suggestion for combining the data in a shared information system is a good first step. In clarifying objectives and planning evaluations, we should also seek to learn from the experiences of similar efforts and not repeat their errors.

In reviewing programs that began in the 1960's and 70's, for minorities generally, noted experts Dr. Charles V. Hamilton and Dr. Dona Hamilton wrote:

"The presumption was that if jobs were available for most, then those who were left out very likely needed special training and/or services before they could be employed. This was sufficient and reasonable justification for the creation of an elaborate set of service-oriented programs... In the process the country embarked on an experiment probably more laden with policy risk than at any other time in its history.....

And a curious phenomenon ensued. Proponents of the programs complained from the outset that the experiment was bound to fail unless more resources were committed. Some more funds were allocated, but according to the supporters, never really enough. Subsequently, when critics accused the programs of failure, the proponents were forced to defend what modicum of achievements they identified. Throughout --and now [1984] -- criteria for measurement were confused and complicated...Programs were implememted that were aimed at addressing various pieces of the problem, but all too frequently assessments were made on the whole."

In this study there is much that will assist us in avoiding the repetition of others' mistakes. There is good advice in this report and, most important, help in framing the right questions for further study.

Carole A. Morning, P.E.
October 1986

INTRODUCTION

It is the underrepresentation of low status ethnic minorities (blacks, Hispanics and Amerindians) which led to considerable effort over the past 15 years to increase the participation of persons from these groups in the engineering profession. The great bulk of this effort has been directed at precollegiate and collegiate programs in engineering education with a smaller but highly significant effort directed at increased opportunities for postgraduate education. It is a sample of these pre-collegiate and collegiate programs which is the focus of this study. The purpose of such a focus is to report on the "state of the art" in contemporary educational interventions designed to increase participation of ethnic minorities in careers in engineering. The specific focus is on programs at the precollegiate and collegiate levels which are directed at expanding the number of underrepresented ethnic minority group members earning bachelors' degrees in engineering and the engineering sciences. The study was conducted in three parts.

Part I is a review of published and fugitive literature concerning such programs and practices in order to (a) determine the nature and extent of current work in this field, (b) establish criteria by which exemplars of this work may be identified, and (c) select candidate programs for inclusion in an

analysis of exemplary programs and practices.

Part II of this study consisted of a survey of selected programs to collect detailed information concerning characteristic features of programs, participants, personnel, practices, settings, costs, and outcomes.

Part III of this study consisted of a "state of the art" report, in which the results of Parts I and II are summarized and integrated with the considered judgements of the principal investigator, whose judgments and interpretations have been informed by consultation with a panel of experts. This report (a) addresses the nature and quality of these interventions; (b) describes programs and practices that show promise of, or have demonstrated, effectiveness; and (c) assesses the potential limits of such work in the context of the problems that have made these interventions necessary.

Because the study is based upon voluntary returns of a survey instrument mailed to 115 programs of which 53 responded, and because the study design enabled site visits to about one tenth of the programs from which we received responses, we have avoided making evaluative statements concerning specific programs. Rather, the report addresses developments and trends in this field as they are reflected in the research and professional literature and in the aggregated survey data. We have come to the end of this study impressed by the magnitude of activity which has been undertaken; by the sizable gains in the inclusion of underrepresented minorities in engineering education and engineering professions; by the variety of constituencies and strategies which are involved in the effort; and by the diverse

conceptions of the mission which are either explicit or implicit in these efforts. These perceptions greatly complicate the task of evaluating the quality of our current "state of the art" in engineering education for underrepresented minority students.

PART I

THE QUESTION OF MINORITY REPRESENTATION IN ENGINEERING

The cultural, economic and social history of the United States has been greatly influenced by developments in the education of its people. Among the founders of the nation were persons like Thomas Jefferson who saw education as a crucial requirement for the success of the emerging Republic. Despite the breadth and richness of his own intellectual development, Jefferson's concept of formal education appears to us in the late twentieth century to have been rather limited. He saw schools providing the basics - literacy, arithmetic and some core knowledge - but looked to commercial, social and political intercourse for the broader education of the citizenry and for vocational training.

Jefferson's view of education may have been appropriate to that early period in the development of the nation, but before the nation was one hundred years old secondary schools and some colleges had been developed to provide the quality of advanced education typified by Jefferson's own liberal education. By the time the nation was two hundred years old, the changing demands of commerce, industry and technology had forced it to look for more from its schools and to begin a debate concerning the utility of liberal education vs. vocational/technical education. It is interesting to note that Jefferson had acquired both. By the latter part of the nineteenth century the nation had begun to create its land grant colleges, the curricula of which were

dominated by vocational/technical concerns and their student bodies drawn from lower middle class, lower class and farm populations which had not been attracted to (and in many cases not admitted to) the private colleges and universities which taught the liberal arts and sciences. This emphasis on applied concerns reflected the growing industrialization of the nation and the institutionalization of its commerce.

It was onto this bifocal system of education that issues related to the education of European immigrants, recently freed blacks and poor indigenous whites were laid. The earliest debates were around the establishment of free public elementary and secondary schools, a goal that blacks and whites combined forces to achieve during the period of Reconstruction following the Civil War. By the turn of the century the debate focussed on the nature of the education to be made available to low status persons. The controversy was typified in the classic debates between W.E.B. DuBois and Booker T. Washington, in which DuBois argued the importance of education in the arts and sciences and Washington argued for the training of the hands of blacks so they could enter a labor force based on vocational skills. The continuing struggle for the democratization of access to and achievement in education was to be shaped by the fact that Washington's position was accepted nationwide, and, until the late twentieth century, the DuBois position was ignored. As so often happens when issues are subjected to vigorous public debate, positions harden and compromises which both antagonists might accept are ignored. In a speech that is seldom referred to, DuBois acknowledged the utility of vocational skills

development and urged that they be combined with the development of the intellect, correctly predicting that the integration of these competencies would be an increasing requirement of advanced industrial (technological) societies. All but lost in the midst of this debate was DuBois's concern for the nurturance of intellect, especially in what he referred to as the "talented tenth" of the population.

As the struggle to democratize educational access and achievement progressed, attention was concentrated on access to the basics and vocational training rather than to liberal arts and science education. Thus the publicly sponsored high schools and colleges for blacks developed with strong emphasis on practical and vocational/technical skills and the private institutions for blacks gave varying degrees of attention to the liberal arts and sciences. Under a parallel set of pressures, the perceived needs of blacks to prepare to enter the labor force, plus the lower costs of the public institutions, private institutions serving blacks found it easier to attract students to applied training in "employable" skills than to programs which focussed on the liberal arts and sciences and which were viewed as nonmarketable.

This brief historical review places in perspective several of the problems which are involved as we turn to preprofessional and professional engineering education of blacks and other underrepresented minorities. It is this history which helps to explain such phenomena as:

1. the limited pool of underrepresented minority students

available for collegiate and postbacculaureate engineering education;

2. the absence of solid academic course work in many of these students;
3. the non-analytic tradition often thought to be associated with the communities from which these students come;
4. the attraction of engineering as possibly a quicker route to professional employment, for a large segment of the minority population of able students, than would be true of professions requiring postgraduate education.

It was in the middle and late nineteen-sixties that the United States experienced what is probably its most extensive efforts at enabling disadvantaged citizens to more fully benefit from the opportunities promised in the Civil Rights Movement of the fifties and sixties. Certainly in education, democratization efforts were greatly increased. By the end of the sixties, every school system that served low status minority groups had participated in federally sponsored compensatory education, and most colleges and universities had initiated some effort to assist disadvantaged and minority students. It is engineering and engineering education which seem to have taken the lead in these efforts. From the corporate industrial sector, there arose a concerted effort to increase the representation first of Blacks and then of Hispanics and American Indians in engineering. This development was in the tradition of this segment's leadership of philanthropy in this country. Engineering may have been chosen because that is the kind of talent that industry requires, but also because in the period of the 1950's and 60's,

engineering was the established route to senior management in the old-line industries. So significant was this effort that in numbers of students served and impact on the underrepresentation of minorities in the profession, engineering has improved more than any other profession. James Blackwell (1981) has argued that:

> . . .in terms of absolute numbers of students enrolled no professional area can legitimately claim as much success in changing the racial composition of its field as can the profession of engineering. None can claim as much direct involvement and participation of the corporate structure in the concrete programs designed to assure the inclusion of blacks and other minorities in a profession. None can demonstrate so rapid an increase in the actual production of a greater number of minorities for the workforce.

Since 1969, there has been steady growth in the number and ethnic distribution of minorities receiving degrees in engineering. Table 1 (from the 1985 Report of the National Action Council for Minorities in Engineering) reflects this growth.

Although it is difficult to explain definitely why this unique development occured in engineering, some persons interviewed attribute the achievement to the manner in which the field organized itself to respond to the need. Others suggest that engineering is particularly attractive to able minority students because it promises employment with substantial income after four or five years of postsecondary education, incontrast to medicine, law or the scholarly disciplines which require seven to twelve years of postsecondary study and in some instances a lesser chance of satisfactory employment. Nonetheless, engineering also benefitted from the nation's growing concern for the democratization of the labor force, and from our changed

TABLE 1

MINORITY SHARE OF BACHELOR'S DEGREES IN ENGINEERING, 1969-1984

YEAR	BLACK	HISPANIC*	AMERICAN INDIAN	TOTAL MINORITY	TOTAL DEGREES
1969	314				39,972
1970	378				42,673
1971	407				42,856
1972	579				44,190
1973	657	566	32	1,255	43,086
1974	756	636	31	1,423	41,010
1975	734	685	44	1,463	37,835
1976	777	658	41	1,476	37,609
1977	844	702	36	1,582	39,718
1978	894	748	37	1,679	45,753
1979	1,076	808	59	1,943	52,161
1980	1,320	1,003	60	2,383	58,413
1981	1,446	1,193	90	2,728	62,615
1982	1,646	1,270	91	3,007	66,652
1983	1,862	1,534	97	3,493	72,122
1984	2,022	1,683	112	3,817	76,576

*Figures do not include the University of Puerto Rico.

Notes:

Annual reports, bulletins, and publications of the Engineering Manpower Commission (EMC) were used as sources for these tables. EMC cautions that information is subject to error. All information has been verified by the EMC.

Statistics for minorities, other than Black, are not available before 1973. Also, the total undergraduate enrollment figures before 1973 may or may not include the University of Puerto Rico.

NACME, 1985

perception of the personnel needs of an advanced technological society. Like other professions and disciplines, engineering no doubt recognized the need for the more balanced perspective provided by ethnic diversity in its members. Civil Rights advocates would remind us that none of these reasons would have sufficed without the political struggles that raised the consciousness of the nation to the injustice of exclusion and the potential value of inclusion.

In recent years we have been studying programs of academic development designed to serve underrepresented minority populations. It is clear from these investigations that the kind of questions asked, the manner in which the data are collected and the interpretation of these data depend in large measure on how the problem is conceptualized. Indeed, the engineering education programs we have studied have been shaped by these various conceptualizations. It appears that the designers of some of these programs would claim that the task of educating minority engineers involves identifying talented minority students who are capable of pursuing and benefitting from rigorous preparation in mathematics, the sciences and engineering. It appears that others attempting to increase the number of minority students in engineering would not only limit the task to searching for those bright young people who are interested in engineering, but would also seek to develop their interest and to motivate them. Still others approaching the task would tend to stress the importance of expanding the minority talent pool by developing early intervention programs which would ensure that potential talent is not underdeveloped or entirely

lost.

These three approaches have in common the goal of seeking greater minority participation in the field of engineering. In addition to this, they include the concern for mitigating the financial difficulties that minority engineering students often face. One does not sense, however, from these approaches an understanding of the importance of defining the nature of "greater minority participation." A small group of scholars believe that the task necessarily involves enabling a significantly larger number of minorities to excel and to achieve leadership in the field of engineering. At the other end of the continuum are those who are neither concerned with entry of minorities to the field of engineering or with their attaining leadership status. In between are many persons who feel that the task is to increase participation by underrepresented minorities at whatever levels possible. Persons holding this view might argue that until there is a critical mass of minority participants leadership is not likely to emerge. There may even be some people in the field who are content to meet the requirements of affirmative action, but have no special interest in the career development of these underrepresented minority members. Yet another group includes those who are concerned with preparing minority students as lay person participants and not as professionals working in a society which is rapidly becoming dominated by technology, mathematics and science.

In this study, we have not been able to discern a well-conceptualized sense of mission that reflects consensus with

respect to the nature of the problem with which we are dealing or the specific nature of the goal we seek to achieve. The absence of such a conceptualization has left room for the emergence of a wide range of interventions, but it has also precluded specificity of attack on the problem and has greatly complicated the task of evaluating the impact of these interventions. The field of engineering includes creative scientists who work at the growing edges of knowledge and technology, scientist/ philosopher/ professionals whose work involves decisions in public policy that challenge the wisdom of Solomon, highly skilled technicians whose task it is to apply knowledge and technique in situations where precision and systematicity within a very narrow range of tolerance is the challenge, and socially sensitive professionals who can bridge the gap between the humanistic and the technocratic. The field also includes professional work on very practical and mechanical problems in electricity, electronics, plumbing, and climate control. These and other demands of the field require quite different kinds and degrees of ability, competence and preparation. The varied demands of the profession, together with the diversity of the people we seek to prepare for the field, and differences in conceptions of the problem and the mission with respect to underrepresented minorities, all make it critical that our efforts at increasing minority participation receive better conceptual direction. This may be one of our most important unmet needs.

Although there are varying conceptions concerning the cause and nature of the problem of underrepresentation of minorities in

engineering, there is little room for dispute concerning one of its principal manifestations and impediments to easy resolution. The demographic data not only suggest that the pool of ready candidates is severely limited, these data also suggest that the magnitude of needed corrective effort may be greater than any so far undertaken, and that the time of optimal intervention may be earlier than is typical of almost all extant programs. If we assume that high academic achievement is a prerequisite for the study of engineering, then according to the 1980 High School and Beyond data (see Table 2) we are limited to less than a tenth of the minority population in contrast to nearly a quarter of low SES whites and close to one half of high SES whites. The actual number of students represented by this 10% appears even more problematic when we consider that between 1974 and 1984 we were graduating from high school about 75% of the black cohort and 61% of the Hispanic cohort. In addition, it is generally agreed that successful completion of an engineering degree at a moderately selective institution, without special assistance, is unlikely for students with a combined SAT score of less than 1000. If we are correct we should be selecting from the top 7.6% (or 4,376) of all blacks who took this examination in 1984. If we lower the cut-off score to 910, we gain an additional 7.3% making our pool about 15% of an already selected pool of black students, a total of 10,562 students. (See Table 3.)

Further complicating the limitations of the pool is the fact that when we examine the 1984 data relative to the distribution of blacks by SAT score range and selected intended areas of study

TABLE 2

PERCENT DISTRIBUTION OF 1980 HIGH SCHOOL SENIORS OF HIGH AND AVERAGE ABILITY, BY RACE, ETHNICITY, AND SOCIO-ECONOMIC STATUS

Variable	High Ability	Average Ability
Total Sample	30.7%	69.3%
% Female	48.6	54.3
% Low Quartile, SES	10.3	31.9
% High Quartile, SES	41.3	16.3
Race/Ethnicity/SES Categories		
% Blacks	8.2%	90.8%
% Low SES Whites	23.9	76.1
% High SES Whites	46.4	53.6
% Hispanics	8.0	92.0
% Mexicans	7.3	92.7
% Cubans	16.9	83.1
% Puerto Ricans	10.6	89.4
% Other Latins	9.0	91.0

Note: High ability students are those who scored at least .5 standard deviation units above the mean on high school achievement. (X=50, s.d. = 10.)

Source: Valerie Lee, Access to Higher Education: The Experience of Blacks, Hispanics, and Low Socio-Economic Status Whites. Washington, DC: American Council on Education, 1985. p 42.

(An analysis of High School and Beyond data)

TABLE 3

DISTRIBUTION OF COMBINED SAT SCORES
(ALL BLACKS, 1984)

Score	Number	Percent
400	105	0.1
410-500	7,148	10.0
510-600	15,734	22.0
610-700	14,805	20.9
710-800	13,569	19.0
810-900	9,268	13.0
910-1000	5,186	7.3
1010-1100	3,486	4.9
1110-1200	1,033	1.5
1210-1300	665	0.9
1310-1400	175	0.2
1410-1500	17	<0.1
1510-1600	0	0.0
Total	72,218	100.0

Note: Total may not sum to 100% due to rounding.

Source: SRS 1984 National Minority Sample, College Board, as reported in Who is Going to Medical School? A Look at the 1984-85 Underrepresented Minority Applicant Pool. By Joan C. Baratz, Myra S. Ficklen, Benjamin King, and Paul Rosenbaum. Princeton, NJ: Educational Testing Service, 1985. p 78.

we find that for blacks who score at least 1100, 36.2% have indicated engineering as first choice. If we drop to 910 and above, 57% of black students have indicated engineering as first choice. Although the figures speak well for the attractiveness of engineering to this population, one might justifiably be concerned about any single profession's claim on the interest of 57% of our possibly best prepared students.

Another perspective is provided when we consider that the 36% of students scoring 1100+ amounts to 753 actual bodies. The 57% scoring at 910+ amounts to 2,417. The total number of engineering bachelor's degrees awarded to blacks in 1980-81 was 2449 or 3.3% out of a total for the nation of 74,954 bachelor's degrees in engineering. (Thomas, 1985) These are modest numbers of students even though they represent significant increases in the participation of minority students. The 1984 NACME Report includes numbers that vary somewhat from the Thomas figures quoted above but the numbers reflect a continuous increase in the number of bachelor's degrees in engineering over the past 15 years. (See Table 1.)

Given the number of minority group members who have been graduated from engineering schools (about 2000 blacks, 1600 Hispanics and 112 Amerindians in 1984) one could argue that we have dipped deeper into the pool than the figures above would indicate. However it is sobering to focus on findings from the study "Who Will Do Science?" These investigators indicated that minority science participation (especially as it relates to the production of doctoral scientists) is influenced by the following factors:

1. By the conclusion of high school only those already in the scientific/mathematical game have the option of continuing to play it.
2. Early college-tracking, early scientific/mathematical interests, and substantial investments in junior and senior high school science and mathematics courses are precursors of post-high school entry into quantitative training and careers.
3. The underrepresentation of non-Asian minorities seems traceable to the negative consequences of lower family social status, especially parental education, on early college tracking, occupational horizons, and academic performance.

What this specifically means is that the scientific talent pool's membership emerges before 9th grade and is usually completed by the 12th grade. Before the 9th grade, membership in the pool is determined more by quantitative interests than by skills. (Passow, 1984) Most younger students are included in this group because of their generally inquisitive natures and by the fact that many younger students are not so negatively affected by science and mathematics stereotypes and attitudes as are older students. By the 12th grade, this pool becomes more defined along the lines of ability and exposure. Many of the students in the scientific/mathematical pool by grade 12 have taken the advanced precollege courses requisite for majoring in quantitative fields. The talent pool reaches its maximum size before high school and migration into the pool continues to occur

during grades 9 through 12. However, after high school migration is almost entirely out of, not into the pool. (Berryman, 1983)

This "problem" must be put in the context of differences in the expansion of the white and nonwhite talent pools. There are differences in attrition rates for whites and underrepresented minority groups at various points of the educational ladder. These differences can explain certain aspects of each group's relative representation in the science/engineering workforce and the doctoral science/engineering pool. John H. Hall (1984), in his description of the long-tern activities for minority institutions in science and technology at the 1984 National Science Foundation-sponsored Lake Arrowhead Conference states that out of every 100 whites who enter first grade, 83 complete high school, 23 complete college, and 8 complete graduate or professional school. By comparison, for every 100 blacks (there is more data on blacks than on other minorities) who enter the first grade, 72 of them complete high school, 12 complete college and 4 finish graduate or professional school.

In addition, according to the 1980 statistics in the Lake Arrowhead report, 34% of black high school seniors had taken remedial math while 20% had enrolled in advanced or honors mathematics. The figures for Native Americans and Hispanics are even lower. Hall goes on to state that the literature documents a direct correlation between socioeconomic status and the percentage of advanced or honors math courses (note that 70% of black college-bound seniors in 1981 came from families whose annual income was less than $18,000). This profile is repeatedly seen in the literature and is of particular concern given the

fact that high school math and science courses determine whether a student can pursue a quantitative degree in college.

In giving more dramatic statistics on non-Asian minority underrepresentation, Berryman (1984) shows that, relative to their share of the age-relevant populations, blacks, Hispanics and Native Americans are underrepresented at all degree levels in all fields. (Age-relevant populations are defined according to the median ages at which a particular degree is awarded: 21 years old for the associate degree, 22 years old for the B.A. degree, 25-29 years old for the M.A., and 30-34 years old for the Ph.D. degree) The figures for the quantitatively-based fields for each racial/ethnic group are as follows:

Racial/Ethnic Group	Degree			
	B.A.	M.A.	Ph.D.	Professional
Whites	1.13	1.12	1.12	1.12
Blacks	0.32	0.21	0.16	0.35
Hispanics	0.55	0.29	0.21	0.47
Native Americans	0.43	0.50	0.33	0.50
Asian Americans	1.93	2.79	2.71	1.58

*Source: Who Will Do Science?, Rockefeller Foundation Report, 1984

The ratios indicate whether or not a group is representative; a ratio of one for a given degree level implies that the group has a degree share equal to its population share. From this chart, we can see that whites and Asian-Americans are overrepresented at all degree levels.

What do these figures tell us? Unless we are overestimating the level of developed ability required for successful pursuit of the bachelor's degree in engineering, we have just about exhausted the pool of minority students who are fully competitive

for admission to baccalaureate studies in engineering. Since the number of graduates pretty much equals our estimates of students traditionally eligible for admission, it appears that institutions may already be dipping more deeply into the limited pool and that something is happening in these programs which enables these less traditionally well-prepared students to succeed. Despite these evidences of success, minority participation in engineering education continues to be 50% to 75% lower than one would project based upon the size of the minority population in relation to the whole population. Although more complete figures are available for blacks than for Hispanics or Amerindians, it is clear that progress is considerably less for the latter two populations. What these data do not reveal is the relationship of admission to completion. How well do these institutions do with the students they admit? One very crude indicator is the ratio of undergraduate degrees to graduate degrees.

For 1980-81 the Thomas data indicate:

	# of BA's earned	% of BA's earned	# of MA's earned	% of MA's earned	% of BA's earning MA's	# of PhD's earned	% of PhD's earned	% of BA's earning PhD's
Blacks	2449	3.3	360	1.5	14.7	24	0.9	0.98
Hispanics	1433	1.9	278	1.7	19.4	23	0.9	1.6
Whites	60848	81.2	10047	62.0	16.5	1352	53.0	2.2

If we combine eligibility and motivation as an indicator of productivity, these figures suggest a low level of productivity in our undergraduate preparation. An additional comparison is the minority to white percentages of students earning master's

and doctoral degrees in engineering. These figures are truncated and favor whites who in 1980-81 received 62% of the master's degrees to about 3% for minorities and 34% others, and 53% of the Ph.D. degrees to about 1.8% for minorities and 45% others (probably foreign students). (Thomas, 1986, Table 7)

The picture we have is one of considerable progress in the inclusion of minority participants in engineering education. However, despite these successes of which the field can be proud, most of the literature on minority science education, and specifically on engineering education for minorities, indicates that much more needs to be done if we are to democratize the profession and meet the nation's personnel needs in an ethnically balanced way. Many observers indicated that there is a widening "high-tech gap" between the majority community and the minority community. The possibility of creating classes of individuals who can only participate in the lower strata of the post-industrial service economy is a very real threat. The National Commission on Excellence in Education (1983) asserted:

> Knowledge, learning, information, and skilled intelligence are the new raw materials of international commerce and are today spreading throughout the world as vigorously as miracle drugs, synthetic fertilizers, and blue jeans did earlier. If only to keep and improve on the competitive edge we still retain in the world markets, we must dedicate ourselves to the reform of our educational system for the benefit of all - old and young alike, affluent and poor, majority and minority. Learning is the indispensable investment required for success in the "information age" we are entering. (Berryman, 1983)

Some may argue that this concern with the focus and quality of public education has little to do with engineering education for minorities. Despite the effectiveness with which this field has

moved to increase minority participation, there is a tendency to mask important problems which might hinder future efforts.

FACTORS INFLUENCING READINESS FOR THE STUDY OF ENGINEERING

On the precollege level underrepresentation is especially influenced by some of the following factors (some of these factors also apply to collegiate science and mathematics):

Institutional/programmatic factors

* Little emphasis on skills development
* Poor counseling
* Exclusion based on race/class/gender and general background expectations
* Inadequate facilities for science instruction
* Lack of common goals and aims; weak focus (i.e. What does the program hope to achieve for a particular target population?)

Instructional factors

* Insufficient teaching preparation in math and science
* Ineffective practices in both math and science teaching
* Lack of teaching expectation and motivation
* Lack of skills/interest in teaching minority students
* Overemphasis of drill and memorization of facts
* Underemphasis of understanding and application of concepts to the students' environment
* Neglecting to incorporate manipulative materials & hands-on activities as regular instructional strategies
* Disregarding the need for systematic instruction in how to solve problems
* Focusing exclusively on science content, giving little emphasis to the process of science which develops transferable thinking skills
* Teaching from the textbook or by "teacher talk" most of the time

Student factors

* Attitudes
* Persistence
* Stereotyping
* Perceived utility of education
* Academic deficiencies
* Learning styles

* Poor self-concept
* Ability to relate instruction to previous learning experiences
* Language problems for language minorities
* Influence from parents, peers, teachers, and counselors

The greatest factor limiting minority science participation appears to be academic preparation and to a certain extent academic socialization. Much of the literature stresses the importance of hands-on experience in understanding abstract scientific principles. Those programs which are described as more effective in increasing the minority science talent pool often adopt a more hands-on approach combining field trips, problem-solving exercises and computer assisted instruction as opposed to a curriculum emphasizing theory or formal study through lecture and discussion. Harold Fisher (1984) discusses a study of two curriculum models involving the Minority Introduction to Engineering (MITE) and the RCA Minority Engineering Program (MEP); the conclusions of this study show that for minority students, a performance practice oriented curriculum is more effective. Effectiveness was measured by student results on four subtests - verbal, math, science, and mechanical comprehension - of the National Engineering Aptitude Search test. The study suggests that theoretical knowledge alone is not sufficient to prepare minority high school students for engineering study and that technical know-how through application under the guidance of role models is more desirable.

McDermott and Ignatz identified the underdevelopment of mathematical and verbal skills as being a limiting factor for minority participation in the sciences at the college level.

They also found that the lack of mathematical skills was more of a limitation than the lack in science background for success in the sciences. Green, Parson, and Thomas stressed that the development of problem-solving strategies, self-confidence and personal academic standards was of vital importance to successful minority participation in the sciences.

It is interesting to note that most of the literature on engineering education for minorities refers to minority students who have been identified as showing potential for success in engineering. This is probably because practically all of this work was conducted with selected populations. Consequently the weaknesses and problems identified so far are likely to be even more severe in less traditional populations. Yet if the pool is to be expanded, we must turn to those less traditional populations far earlier than do most of the extant programs. Some may argue that this early intervention with a view to increasing math and science competency does not legitimately concern the field of engineering education. Such an argument is debatable unless we ignore the need to expand the talent pool for engineering and unless we forget about the problems associated with developing excellence and leadership in underrepresented minorities in this field.

Even though we have greatly increased minority participation in engineering, it is this investigator's impression that the minority group members of the profession are disproportionately clustured at the bottom levels of the profession. We do not know a great deal about the life histories and development of exceptionally able engineers. We do know from Bloom's studies

(1985) of exceptionally able persons in other areas and Gordon's studies of Defiers of Negative Predictions for Success that most high achievers began their preparation early. In Bloom's work and my own, it was not so much that talent was demonstrated early but that opportunities for appropriate learning began at an early age and were sustained. We realize that there can never be 100% winners, but winning in competition based upon competence requires the investment of preparatory opportunity and effort. What is the natureof that preparatory opportunity and effort?

PART II

COMPONENTIAL ANALYSIS OF EXTANT PROGRAMS

There appear to be four levels of developmental and pedagogical intervention currently available in helping prepare minority students for the study and practice of engineering. 1) There are techniques and practices which are widely used in varying degrees, in more than 100 programs in high schools and colleges across the country. These techniques and practices are generally rooted in the concepts and technologies of compensatory education academic enrichment and remedial education. 2) There is a growing body of experimental work generally led by faculty members who are concerned with the problems of curriculum, teaching and learning in engineering education. This work is most likely to be found in mathematics, physics and the logic of problem solving (if the latter may be called a discipline or metadiscipline). 3) A third body of practice is dominated by affective and psychosocial concerns and relies heavily on motivation, modeling and psychosocial support. This affective and sometimes political emphasis is more likely to be found in programs where developed ability is perceived to be less of a problem and in programs with prominent minority leadership and/or heightened sensitivity to the adjustment problems of minority students. 4) In recent years a body of work has emerged in the behavioral sciences which is concerned with the mechanisms and nature of cognitive development and intellective functions. This work, broadly referred to as cognitive science, includes a group of investigators who are beginning work on the applications of

cognitive science to the problems of education. Just as there are not yet clearly established and empirically supported implications of this work for pedagogical practice, there are also few established bridges between this community of scholars and those who are working on problems in engineering education or specific to the engineering education of minority students. It is around these four levels of intervention that what we know concerning the "state of the art" in this field can best be presented.

The primary sources for this review are 1) a survey of programs for minorities in engineering education conducted by the investigators for this study; 2) the Directory of Precollegiate and Collegiate Programs in Engineering for Minority Students prepared by the National Action Council for Minorities in Engineering; and 3) a review of relevant bibliographic materials. The techniques and practices in this field have been greatly influenced by compensatory and remedial education and reflect an interesting mixture of conceptions concerning the nature of the problem. Since most of the programs are moderately selective, we see evidence of the conception that developing the interests of and financial support for able minority students is at the core of the problem. On the other hand, most of the programs also reflect in their services the notion that minority students tend to be less academically proficient than majority-group students and therefore need supplementary academic support. Some programs seem to view the problem as not so much improving developed ability but helping in accomodation of and socialization to the demands of serious academic pursuit. Thus a rather wide range of

components and emphases is present in varying combinations in extant programs. A description of these components follows.

GENERIC INTERVENTIONS IN WIDE USE

Recruitment

Efforts at recruitment are more common in relation to specific institutions than to the field in general. The bulk of recruitment occurs as part of institutional efforts to build and maintain diverse student bodies. These efforts include publications, school visits, representation by alumni or current students, established relations with college placement services and/or the guidance staffs at specific schools, financial aid packages, on-campus visits and a host of related activities, as the more selective institutions seek out young persons who show talent or promise in mathematics and the sciences. As we have discussed elsewhere, the existing pool of traditionally developed talent may be sufficiently limited to require qualitatively different efforts. Exceptions are several of the precollegiate career guidance programs which are not connected with any one place of study for the profession, and groups like the California Association of Black Engineers, which seeks to attract minority students to the field generally.

Career guidance and introduction to careers in engineering

This work, which is designed to acquaint young students with engineering as a career option, is found most often in precollegiate programs. Program activities include written and

audiovisual materials distribution, lectures and demonstrations, field trips and summer or other short term employment in engineering settings. The intent appears to be to attract new students to the field as well as to reinforce the interests of students who have already given some expression of interest or choice. In a few instances specialized high school programs have been developed where concerted attention is given to the precollegiate preparation of students and efforts are made through work in the lab and the field to provide students with hands-on experiences in the use of math and science to solve practical engineering problems.

Admissions

Probably because of the traditional association of engineering education with relatively rigorous academic demands there was not a rush toward "open admissions" in engineering education. In our survey, institutions were about equally divided between those who reported "academic excellence" and "regular college admission" as a requirement. As best as we can extrapolate from data intended for other purposes, minorities as a group are admitted to the study of engineering with entry qualifications somewhat lower than white students and with a combined SAT score range of 800-1500. Minority students scoring above 1300 are few, but in order to account for the number of minorities graduating from engineering schools we must be admitting more than a few students who score below 1000. Since enlightened admission policies require that more than test scores be used, attention is given to indications of promise in

mathematics and/or the sciences, to level of demonstrated interest in and facility with technical applications and systematic approaches to problem solving. Because of the vocational attractiveness of engineering, many teachers and guidance staff are important sources for the identification and informal assessment of marginal but promising students. Where these school personnel have established reputations for identifying good students, their recommendations are important in the admissions decision. In recent years we have noted a trend, particularly in the more selective colleges, to seek and admit minority students whose backgrounds are more like those of traditional white students and to give less attention to minority applicants from backgrounds of greater educational and social disadvantage. Nonetheless, the exceptionally bright minority student is still sought after. In some institutions, attention is also given to the highly resilient, resourceful and natural leader types, in the assumption that academic or test performance may not be adequately reflect the quality of the underlying intellect. However, in engineering admission, as demonstrated ability and talent is expressed in areas more distant from mathematics, science and technical subjects, admissions chances decline.

Financial aid

Probably no special service is more frequently encountered in engineering programs for underrepresented minority students than is financial aid. These services generally include student loans (the most widely available kind of aid), scholarships,

special grants, and work-study arrangements. Although awards of financial aid are most often based upon demonstrated need, it is not uncommon for particularly attractive students to be offered financial aid packages as a part of the recruitment effort. Institutions vary in the level of sophistication they bring to bear upon the packaging of financial aid. Some appear to take a mechanical approach which makes available any of the standard components, while others go to great lengths to tailor packages which meet the basic needs of students and which are sensitive to the non-academic pressures of minority students. Among these pressures are actual or perceived need to replace resources that would otherwise be available to the family were the students working full time rather than studying. Some institutions give attention to problems of cash flow and money management, others simply make the money available and leave it to the student to manage its use. In few institutions does it appear that the financial aid budget is adequate to meet the demand. This has become an especially acute problem as Federal and scholarship funds have declined. For most minority students, adequate financial aid may be a critical factor in determining whether they successfully complete an engineering degree, and special attention should be given to providing students with the necessary resources in a timely fashion.

Counseling

Academic and personal counseling plays a key role in any Minority Engineering Program. The different personal problems that students face make it mandatory that MEP's provide competent

personal counseling services for their students. In many instances, minority students are plagued by financial or family concerns, psychological problems such as poor motivation, social adjustment to college life, or alienation, and conflicts between working and studying. Although this is an important area of need, there appears to be a shortage of qualified personnel to counsel ethnic minorities who come from diverse cultural backgrounds. Very often, counselors who are not sensitive to diverse cultural forms and values of ethnic minorities tend to misunderstand or misinterpret students' problems, and they run the risk of appearing unempathic, patronizing and uncaring. One program which seems to operate from a perspective which is sensitive to this concern is FAMES, which provides intercultural training for engineering faculty who serve as counselors, mentors and advisors for ethnic minorities at California State University, Northridge. In several of the responses, the counseling services described give considerable attention to providing nurturing environments, selecting and adjusting course loads and sequences, referring students for specialized services, building community and cultural networks, counseling with respect to personal problems, and consulting with faculty and administration on the students' behalf. There appears to be a tension among counselors between the perception of the field as one that provides services to students and one that gives greatest emphasis to enabling students to serve themselves better. Those holding to the former model tend to do a lot of advice-giving, arranging for, placing, and protecting. Those who

follow the enabling model are more likely to educate, to help students examine alternatives, to strengthen decision-making skills, to encourage collective action, and to be advocates of students' rights and opportunities. Both schools of thought give emphasis to academic socialization, study skill development, and resource utilization, i. e., use of tutors, the library, and faculty advisors.

Tutorials

Most Minority Engineering Programs provide tutorial services. Such services enable students to make a successful transition from high school to college, foster their self-reliance and provide them with the foundation necessary for advanced academic work. Tutors in most programs are selected on the basis of recommendations from faculty, high grades in courses to be tutored, overall grade point average, and good interpersonal communication skills. Tutoring services are supported by work-study funds, student governments, or sometimes outside corporate sponsors. In spite of the academic benefits to be derived from such services, many tutoring programs are underutilized by students who seem to think that there is a stigma attached to needing tutorials. In some Minority Engineering Progams, however, an attempt is made to overcome this negative attitude by inviting outstanding older students to address freshmen at orientation on their positive experiences with tutoring and to encourage students to take advantage of the service.

Remedial education

Remediation has traditionally been the primary focus of much of the effort at providing tutorial support to students. It is usually designed to provide supplementary structured learning experiences for students who are assumed to be or have been determined to be deficient in their mastery of one or more academic subjects. The survey response data are not specific with respect to the approaches to remedial work provided. We have determined from the literature, however, that this work includes basic instruction in a subject area that should have been mastered earlier; contemporary coursework presented at a slower pace and at a reduced demand for proficiency; review, drill, and practice designed to fix essential material in memory or skill repertoire. The research on the effectiveness of such remedial practice is equivocal. It seems to be of some help to relatively strong students, but appears to be insufficient to the needs of weak students. Recent years have seen the emergence of targeted remediation, an approach in which instruction is based on psychoeducational diagnosis of the special needs of students to determine the specific nature of the academic dysfunction. Remediation or instructional intervention is then designed or customized to directly address the identified problems. It is not clear that this latter approach is in wide use.

Learning centers

A few of the more comprehensively developed programs report the consolidation of tutorials, remedial education, psychoeducational diagnosis, study skill development and other academic support services in a unit called the Learning Center or the Center for Student Academic Development and similar titles.

These centers began and continue to focus on students who show weaknesses in their readiness to handle college academic work. To dissipate the stigma of "needing help," and out of a growing awareness that the need for greater efficiency in learning is not limited to weak students, a few of such centers are becoming accepted as college-wide resources where a wide variety of persons go to improve upon academic performance. The most advanced of these centers not only provide the services listed above but also help with a variety of academic problems. Readers, for example, who are proficient in reading technical materials are helped to learn to read and appreciate material from the arts, humanities, or social sciences. The reading programs also address problems in basic reading skills. Other services are directed at improving listening skills, problem-solving skills, bibliographic reasearch skills, and writing. Many of these centers have computer and other resources which are used to encourage independent study, the exploration of simulations, and interactive self-assessment in specific subject matter. It is not yet so recognized, but some of us consider that the learning center or student academic development center will become a standard fixture on many of our campuses. Interesting models for such centers may be seen at Harvard University, the University of Pittsburgh, and Rensselaer Polytechnic Institute.

Mathematics and Science Instruction

Probably because math and science mastery are crucial components of the engineering education program, more than one

third of the respondents reported some special efforts in these two areas. Programs described called attention to extra laboratory periods, field experiences, greater attention to hands-on instructional experiences, and to a variety of efforts to enrich or remediate math and science instruction. A very few programs described special efforts at math instruction. The Lopez program at Columbia University is an example in which no new or radical approach to teaching is introduced but very good traditional instructional methods are emphasized. The Lopez model is implemented in regular high schools. It is a highly structured program which, like Bloom's Mastery Teaching, depends on systematic and regular monitoring of student progress, with instruction targeted to those aspects of the work which appear to be giving difficulty. The model reflects the expectation that students can and will do the work and that teachers can and will teach. Other models seem less structured but do use strong teachers known to be effective. Consistency, systematicity, purposefulness, and goal-directed time on task are the common features of these programs.

Problem-solving and critical thinking instruction

A minority of the programs report courses in or emphasis given to problem-solving and/or critical thinking. The survey data provide few details, but it appears that problem oriented instruction and step by step approaches to the solution of problems are strategies utilized. Some programs have discovered the Whimbey and Lockhead Problem Solving and Comprehension text. The work in critical thinking seems to be more nebulous, with a wide variety of emphases being offered. The prevailing notions

appear to include problem clarification, logical reasoning, multiple perspectives, identifying the steps taken in thinking through the problem, and checking the validity of an answer. The professional literature suggests that practice in these areas has developed from intuition and is just beginning to be joined with the findings from cognitive science which are discussed later in this report. One senses from program descriptions that problem-focused teaching is being experimented with in an increasing number of situations. It appears, however, to be an easier endeavor in the humanities and social sciences than in mathematics and the natural and physical sciences. In the latter areas, tradition weighs heavily on the side of skill and knowledge to be imparted or transferred to the student, since we think of these knowledges and skills as more definitive than those of the humanities or social sciences. Math and science, on the other hand, do lend themselves to application and demonstration of real problems. The difficulty arises in our efforts at encouraging creativity and flexibility of thought in the application of formulae, principles, and theorems concerning which we have not traditionally entertained debate. Hence, much of our efforts at teaching critical thinking and problem-solving are dominated by concern for accuracy and ritual, to the neglect of analysis, imagination, speculation, conditional thinking, and reconceptualization. The emergence of attention to this area in minority engineering education, however, does reflect an awareness of higher order thinking as an essential competence.

Advisors, mentors, and models

Many of the programs make use of faculty members, older students, and professional engineers, to provide individual attention and support to students. The system of faculty advisors is quite similar to its use throughout higher education. Such advising is usually limited to academic planning, but attention is sometimes given to career development and personal problems. Where it works best, the faculty advisor is the student's primary source of contact with the college and is the person who mediates the collegiate learning experience. We have not identified a program where this model has been optimally implemented, and exemplary practice is more likely to be idiosyncratic to individuals rather than institutions. Some programs dignify the faculty advisor function and refer to it as a mentor relationship. From discussions with people in the field, it is clear that this model occasionally develops at the graduate level, but seldom do we find at the undergraduate level the intensity of relationship and the concern for shaping attitudes, appreciations, understanding, and competence that we associate with mentoring. The mentor relationship is usually much more personal and even though contact may not be intense, the influence of the relationship tends to be ubiquitous. The use of models is more discretely developed in these programs. In practice, older students and professional engineers are matched with students for continuing contact or may be used episodically to provide exposure to persons with whom students can identify who have successfully passed the experiences or hurdles the students are facing. Probably the best organized of these efforts is that sponsored by the California Association of Black

Engineers. Several other programs, however, make effective use of their own students and appropriate persons from the community.

Summer programs

In this category we have several programs which utilize combinations of the components described above but are unique because they concentrate on students prior to admission to college and provide intensive exposure to special instructional and field experiences during the summer. In our judgement, the least effective of these programs are those which are limited to one, two, or three weeks of summer intervention just prior to the beginning of the freshman year. The major advantage of these programs is the opportunity provided for orientation to the new environment before the full press of demands of college life is encountered. These short-term orientation programs include familiarization with the physical environment and the resources of the instutions; sample exposure to some faculty members and some indication of what the academic demands will be like; establishing contact with advisors and fellow students; and a fair amount of cultural and social interaction. Probably the most effective of the summer programs are those which involve six or more weeks of summer instruction and which involve the same students for two or three summers with some follow-up during the school year. In these programs, students are identified as early as 9th and 10th grades, and the summer experience is used to enrich and expand their preparation for college. Since weakness in math and science is perceived as a common problem, emphasis is usually placed on this subject matter, with attention also given

to study skills, self-management, and communication skills, especially writing. In between these two extremes are other models which serve useful purposes but all seem directed at supplementing the regular high school experience and socializing students to the demands of college.

Component distribution and emphases

An analysis of the survey returns reveals an interesting pattern of components distribution. As is to be noted in Table 4, the precollegiate programs show the highest frequencies of components present except for financial aid and tutoring. In addition to these two emphases, at the collegiate level we also see some concentrations on counselling and academic enrichment/motivation. One can conclude that the greatest amount of activity and variety of interventions occur at this precollegiate level. Even though many of the experimental precollegiate programs are sponsored by institutions of higher learning, their collegiate programs are more structured and traditional, with little experimental or adaptive intervention. For more detailed descriptions of programs which responded to the survey, please see Appendix A.

INNOVATIONS IN CURRICULUM, TEACHING AND LEARNING

Innovations in curriculum, teaching and learning are only modestly represented in the survey of extant programs. About twenty percent of the programs surveyed reported the inclusion of cognitive development and problem-solving instruction, and a similar proportion reported some attention to curriculum development. Both of these clusters occurred at the

TABLE 4

FREQUENCY DISTRIBUTION BY COMPONENTS
IN MINORITY ENGINEERING PROGRAMS

Component	Category: Pre-Collegiate	Summer Pre-Freshman	Collegiate	Grad
-Counselling	24	2	9	1
-Academic Movivation/ Enrichment	22	2	9	1
-Career Option/Professional Counselling	22		1	
-Field Trips/Tours	21	1		4
-Pre/College experience	20	2	6	
-Science Inst./Labs	19	2	3	
-Math Instruction	18	3	3	
-Recruitment	15	2	5	1
-Introduction to Engineering & Technology	13			
-Cognitive Development/ Problem-Solving	10		2	
-Curriculum Development	10		2	
-Teacher/Faculty In-service Training	9	1	3	1
-Tutoring	9	3	10	1
-Computer Science Instr.	8	1	2	
-Information about College	8			
-Job Placement/Summer Apprenticeship/Co-op	7		6	1

-Mentor/Role Model	6		5	1
-Financial Aid	6	1	8	1
-Remedial Work	6	1	4	1
-Exposure to College Life	5	1	1	
-Retention Services	2	1	4	
-Wages (Pay for Apprenticeship or Job)	2		1	
-Study Skills	1	1	3	
-Community Involvement/ Consulting	1		1	
-Family Involvement	1			
-Reinforcement	1			
-Socialization		3	2	

precollegiate level. At the collegiate level only about 2% of programs report such activities. A qualitatively richer resource is revealed in the review of the literature on research and practice in this area. We find that there is considerable ferment among teachers of disciplines directed at developing more effective approaches to instruction, to the organization of the curriculum and to the learning activities of students. This work is greatly influenced by the notion that learning is most effective when, and may be impossible unless, the learner is engaged in the manipulation and transformation of the data and information which forms the content of knowledge. This constructivist conception of the learning process is rooted in the thought of Piaget and is best reflected in the transition from concrete to formal (abstract) operations in cognitive development. Recent and continuing work in this conceptual frame has focussed on the teaching of problem solving, physics, humanities, mathematics and logic. Prominent in this work is the implicit notion that if one's thinking or mental processes are correct and systematic and if one is actively engaged in the use and restructuring of knowledge, learning will occur. Conversely, when the learner is passive and the learning task is primarily absorptive, true learning (understanding, retention, and utilization) does not or is less likely to occur. Researchers and innovators working from this perspective include:

1) D'Amour (1979) who borrows from Popper's (1959) critical fallibilism to teach problem solving through the critical analysis of conjectures and the systematic pursuit of

refutations;

2) Perry (1963) whose concern with examsmanship leads to the fostering of judicious "risk taking" or "courage spans" (Wertime 1979) to enhance the likelihood of engagement and manipulation as activities in learning. Wertime gives attention to the interplay between attitude and thought in learning and uses the humanities as the vehicle;

3) John Seely Brown (1975 & 1976) and others have given attention to the use of computers as intelligence amplifiers and manipulators to enhance the students' engagement with the subject matter, as well as to help control and restructure the content and the process of learning;

4) Gray (1979), whose work is directed at the teaching of abstraction as a mental skill, argues that the technique of operating on phenomena to isolate abstract characteristics is useful as a means of organization. He distinguishes between concrete and formal operations as well as between active and passive problem solving. He argues further that a passive problem solver is one who permits the problem to dictate actions rather than initiating the type of action to be taken. Using mathematics and physics problems, he illustrates the facilitation of the mental representation and manipulation of knowledge leading to abstraction -- the identification of relationships by which order and organization can be derived;

5) DiSessa (1979) (1975) who argues for more pedagogically relevant models for the representation of knowledge, advances the computational metaphor, which reflects the

procedural nature of human thinking, and forces a concern for knowledge which is self-directing, and organizational (i.e. "control knowledge"). Thus, a more learnable curriculum may be one which augments the traditional set of knowledge-organization schemes (such as axiomatics) with more procedurally oriented ones. This is particularly true if one can choose procedural representations with elements which match as well as possible the natural knowledge-within-process which constitutes much of the intuitive, common-sense knowledge students already have. The concepts are applied in diSessa's work to geometry, math and physics.

Other interesting examples are seen in the work of Greenfield (1979) who distinguishes between product and problem solving. The former, being an answer or solution to the problem, can be observed, examined and graded, but the latter, which is a process, much of which occurs in the head of the student, can only be inferred and sometimes partially reported. Yet it is mastery of the process of problem solving that the teacher must enable the learner to achieve. Another example comes from the work of Schoenfeld (1980) who has developed instructional strategies based on the use of heuristics as levers for stimulating and facilitating problem solving. The heuristic is a schemata, strategy, suggestion or even a term which may be independent of the subject matter, but which is useful in understanding or organizing a body of knowledge. One final example is found in the work of Whimbey & Lockhead (1979) whose handbook on problem solving has attracted considerable attention.

The handbook guides students through a series of progressively more difficult problems and exercises which call into play essential problem-solving strategies. They introduce students to the very useful device of talking out loud while solving problems, thus enabling another person to observe the process, and also possibly contributing to the learner's own monitoring and understanding of the processes used.

AFFECTIVE, MOTIVATIONAL AND PSYCHOSOCIAL INTERVENTIONS

In the Report to the Ford Foundation on Collegiate Programs for Disadvantaged Students (1970), Gordon called attention to a growing awareness of the importance of a critical mass of minority students on a single campus to enable these students to provide moral support for each other and into which to retreat briefly as a respite from the tensions of adjustment in often hostile environments. This finding and other observations from that period continue to appear to be important in the adjustment of minority students to collegiate environments. Almost all of the programs studied give some attention to the affective and psychosocial aspects of minority student adjustment. This is sometimes reflected in the presense of minority group members in leadership or at least front-line positions. In traditionally black institutions, it is often reflected in the nurturing attitudes and behaviour of some faculty members. It is seen in the support provided to some students by organizations of minority professionals. It is reflected in the pre-professional and social organizations students create on campus. Some of the

programs studied invite minority-group members with successful careers to engage with minority students as mentors, in informal social contacts or in work-related encounters. In a few programs, efforts are made to use ethnic cultural resources on campus or in the community, in an attempt to make the minority student feel less isolated. Probably the most widespread intervention is the use of minority group members as counselors with the implicit expectation that students will more readily identify with such persons and that the same group of professionals will better understand the concerns of the minority student.

What is most striking about these interventions is the importance that students themselves and their parents attach to them. One parent interviewed had deliberately selected and pushed a traditionally black institution for his offspring because of the availability of black role models and a nurturing spirit of high expectations from the faculty. He argued that he had seen too many black students "messed over" as they struggled with racist institutions and hostile social environments. Several students referred to the moral support, direction and general assistance they had received from minority staff members. "I couldn't have made it without Mr. _____". Still other students report the comfort and relief felt in the company of fellow black or Hispanic students after many and long experiences where they were the "only" or "one of a very few" in a majority-dominated situation. One student spoke of the satisfaction derived from the discovery that there are other black students "as bright as I am" after being the only black student in the

honors program in high school. These psycho/social and, sometimes, political considerations are often not thought to be related to academic adjustment, but in recent studies of coping behaviour in college students, Barker, Terrell and Gordon (1986) working with black students, and Cabello and Gordon (1986), working with Hispanic students, report that availability of a community of ethnic kinship is perceived as important to academic as well as social adjustment.

In a psychological intervention more directly related to academic achievement, Triesman (1984) reports his finding that black and Chicano students, often having achieved high academic status in high school by isolating themselves from their peers, continued that solitary behaviour in college. Based upon his observation that most of his most able white students studied in groups where they assisted, coached, tutored and quizzed each other, he introduced study teams among his minority students in mathematics, physics and chemistry. The college achievement patterns of these minority students now equal those of white students. Lockhead has used a similar technique in teaching math, where students are grouped and made collectively responsible for teaching each other. They are also assigned a group coach who often attends class with the group. The coach functions as a tutor, advisor and cheerleader in support of the individual and collective efforts of the members of the team. All of the members of the team get the same grade based upon the collective achievement of the group. This seems to encourage the ablest students to help the weaker students and the weaker

students to try harder so as not to penalize their peers.

Still another psycho/social motivational intervention involves the use of contingency management or reinforcement. In this model rewards are used to reinforce positive behaviour and achievement. Based upon the Skinnerian paradigm in which behaviour is analyzed in order to guide the management of contingent events, the instructor or counselor monitors the learning behaviour and/or achievement of the student. Inappropriate or non-productive behaviours are ignored and appropriate or productive behaviours and achievement are rewarded. The rewards may be material or symbolic and may be immediate or delayed. As with all reinforcement models used in learning situations, what we work toward is intrinsic rewards or reinforcement. The goal is to make extrinsic reinforcements unnecessary and intrinsic reinforcements adequate to sustain effort and achievement. Despite consistently positive results, this paradigm has not gained wide usage. This is perhaps due to the difficulty in systematizing the pattern of reinforcements and the colloquial association of material rewards in learning with bribery.

In general, educators have not made extensive use of affective, motivational and psycho/social interventions. As in the cognitive sciences, a body of social psychological knowledge is emerging which could better inform the design and management of teaching and learning transactions. We know, for example, that persons function differently in groups than individually, and that a democratic, as opposed to autocratic, climate in the group influences the productivity of group members. We know that

through social contagion the behaviour of group members can be shaped for better or worse and that attitudes, behaviours and climates in groups can be manipulated. We know that the dynamics of groups can be used to sustain, increase or decrease effort. We know that the composition of groups can influence group and individual behaviour. We know that the belief systems and values which dominate in a group can shape what the group does and how it does it. We have known for some time that identity and self perception influence the behaviour of individuals and groups. It is clear that the expectations of authority figures, as well as expectations of self, strongly shape learning outcomes. Unfortunately, these and other insights are not systematically utilized in pedagogy and are grossly underrepresented in the engineering education programs we have studied. In a few outstanding programs, fragments of this knowledge base are incorporated.

EMERGING APPLICATIONS OF THE COGNITIVE SCIENCES

One can discern at least three relatively independent movements in efforts to facilitate academic development, either in general or specifically in engineering. There is the group concerned with curriculum and instruction. There is the group generally referred to as educational psychologists who seek to apply what is known about human development and learning to education and there are those who identify themselves as congnitive psychologists or cognitive scientists who are concerned with the nature of intelligence and its functional development. What is both interesting and ironic is that

developments in these three areas have tended to proceed with little intercommunication between the three groups. It is thus not surprising to find only modest representation of new developments in educational psychology and almost no influence of findings from the cognitive sciences in the engineering education programs for minority students. We have referred to a few scholars who appear to be on the cutting edge in their innovations in curriculum, teaching and learning. In addition to such work as briefly described, we can identify four general trends in the cognitive sciences which seem pregnant with possibilities for application to engineering education and pedagogy in general.

1) There is a prominent body of work which uses information-processing models to identify the mechanisms of effective and ineffective mental functioning. Sternberg, Anne Brown and Glazer are among those who are associated with this work.

2) In the interest of more effective self-management of learning, increasing attention is being given to the learner's understanding and monitoring of intellective functions. Crucial to these behaviours is the learner's knowledge of her/his own mental processes, which is referred to as metacognitive capacity by Flavell (1976) and metacomponential knowledge by Sternberg (1980).

3) Reflecting the possibility that indigenous rather than exogenous motivation is the driving force behind learning task engagement and mastery, emphasis is given to

attribution and sense of efficacy as learner characteristics to which learning conditions, experiences and materials must be adapted. Bondura and Bransford are investigators whose work reflects this notion.

4) More than twenty years ago Carroll (1963) advanced the notion that learning ability may be a function of time spent on learning tasks appropriate to that which is to be learned. This notion coupled with a concern for structure and systematicity (Ausubel, Bruner, Bloom Meeker and Tauber) is reflected in work which gives emphasis to systematic and structured mediation of learning experiences (Feurenstein) as an essential feature of teaching/learning transactions.

Much of this work remains in its experimental or developmental stages and is, as yet, not ready for routine implementation in classroom instruction. Nonetheless, given the problems we have encountered in bringing large numbers of less-than-well-educated minority young people into competitive achievement levels with their majority group peers, acceleration of the transformation and application of such processes seems appropriate. Let us then examine these notions more closely.

In efforts at better understanding the nature of intelligence, Sternberg, for example, using an information processing model, has pursued what he refers to as the componential analysis of intellective functions. He and other investigators have studied inefficient and highly efficient learners in efforts to decompose or unbundle the complex process that we call learning. Sternberg has identified three types of

components, which he calls knowledge acquisition components, performance components and metacomponential knowledge components. The acquisition components are those behaviours which are employed in order to acquire and assimilate information, knowledge and skill. The category includes such functions as use of mediators, decontextualization, selective encoding, selective combination and comparison. Performance components are those behaviours which are used in the execution of intellective and learning activities. Examples of performance components are inductive reasoning, inferring, mapping, applying and justifying. Metacomponential knowledge is knowledge about the operation of the former two, and competence in their management. Metacomponential knowledge is reflected in such executive functions as identifying the problem, planning an attack upon the problem, managing the execution of the plan, monitoring the execution, evaluating the process and outcomes, and self correcting when necessary. The metacomponential category according to Sternberg includes the former two but is superior to them in that it informs and directs acquisition and performance. What is of particular interest in educational programs for less well educated minority students is that competence in the use of these components can be improved through direct instruction. However, what has not been adequately demonstrated is our ability to bring inefficient learners to transfer the results of such direct instruction to other learning and problem situations. Students appear to learn to apply the components in specific situations or to specific problems, but the new competencies are not generalized to all intellective functions.

This failure of generalization or transfer may be a function of problems in three other dimensions of cognitive function, the availability of knowledge structures, the adequacy of metacognitive competence and appropriateness of dispositional factors. Early work by Bartlett, later theories of Piaget, and investigations of artificial intelligence (Minsky, 1975; Schank and Abelson, 1977; Bower, Black and Turner, 1979), all have highlighted the importance of available units of specific knowledge, conceptual and informational frames of reference, and "schemata" or "knowledge structures" to efficient cognitive functioning. Bartlett demonstrated that in learning new material one uses existing bits of knowledge to anchor the new knowledge. Piaget advanced the notion that intellectual development is based upon "assimilation" -- the use of existing schemata to understand and hold onto phenomena experienced -- and "accomodation" -- the development of new schemata based upon the adjustment and elaboration of existing schemata or knowledge structures. When existing knowledge structures are inadequate or inappropriate, learning is interfered with or precluded just as in computer operations the machine is incapacitated when confronted with problems whose solution depends on information not in its program or memory. Thus, learners may use correct mental strategies but if the knowledge structures essential to specific problems are unavailable, efficient learning cannot occur.

Sternberg correctly emphasizes the importance of metacomponential knowledge and the use of executive strategies, but their presence and function depend on the learner's

understanding and appreciation of such knowledge. Flavell (1976) and Brown (1978) refer to the mental processes by which such knowledge is manifested as metacognition, i.e., knowledge of and capacity to recognize and understand one's own mental functions. Sternberg has elaborated on Flavell's notion and has incorporated into an intellect-enhancement curriculum, learning experiences designed to help learners understand the processes by which their intellectual functioning works. This is in contrast to a curriculum developed by Whimbey and Lockhead which is very useful training in problem solving but which does not give as much attention to the problem solver's knowledge and understanding of the intellective processes which underly the problem solving skills. Resnick and Brown have called attention to the possible absence of appropriate dispositional states to support the generalized or habitual use of more efficient learning or intellective behaviours. Human beings are creatures of habit. If appropriate habits of thought and action are not established early through the incidental learning and socialization of the child, their absence can interfere with the quality of subsequent learning and intellectual function. It may be these habits or personal inclinations -- dispositions -- which form the basis for indigenous motivation.

There continues to be debate in the field over whether we should distinguish between indigenous and exogenous motivation, i.e., whether some sources of motivation are rooted in external stimuli and rewards or if all motivation must ultimately rest on some internal schema. My own studies in this area lead me to believe that the question of internal or external sources of

motivation may be less important than the nature of the motivational force. It must be anchored in beliefs, feelings and attributions which are intrinsic to, i.e., belong and are important to, the person who is being motivated. Under such conditions, motivation becomes the driving force behind task engagement and mastery and is thought to reflect the learner's attributions -- the special meanings or values -- and sense of efficacy: the feeling that the task is doable and worth doing (Bandura, 1981). In a search for ways to make learning experiences more meaningful to the learner, Bransford et al. (1977) found that knowing and understanding the task -- its essential conditions, its structure, its requirements and presumably, its relationship to what is known and unknown -- was a predominant need which can result in task engagement. These concerns are reflected in a curriculum developed by Bruner, "Man - A Course of Study," in which the phylogenetic evolution of the learning process is the subject matter.

> "From the study of how problems of survival are solved by a variety of living organisms, the curriculum ultimately focuses on the student's own learning, aiming to enhance awareness of the evolution and potential of the student's thinking." (Brainin, 1985)

Thus, in this curriculum, the subject matter, the structure and sequence, its familiar conditions, and its relationship to the learner's previously existing schemata, all support motivation and task engagement.

Stimulus structure and relevance not only influence motivation and task engagement; these characteristics are also thought to influence the ease with which things are learned.

Systematic learning experiences, which are organized to reflect orderly relationships between familiar and unfamiliar schemata, are an essential feature of structured mediation in directed learning (instruction). Feuerstein (1980) argues that it is the absence of appropriately mediated incidental learning experiences that contributes to the educational disadvantages of many minority students. In his "Instrumental Enrichment" of mental function, heavy emphasis is given to such structured mediation as calling attention to the salient features of a stimulus, labelling, cueing, eliciting and iterating similarities, refocusing attention and explaining relationships. More than fifteen years ago, Ausubel (1968) introduced the notion "advance organizers" to refer to the practice of exposing learners to a concept, term, model or key word which could be used to organize, gain insight into or analyze new learning experiences. Advance organizers operate in much the same way as mindset. They focus the attention and thought of the learner. They direct the learner's energy. Obviously, there can be disadvantages to such mindsets since they can also limit that which the learner sees or to which the learner responds. The flexible and multiple use of such organizers can, of course, reduce the likelihood of destructively limiting effects. Other approaches to structured mediation include: the use of analogies and metaphors; the expression of intent and purpose; the exploration and assignment of meaning; and the application and transfer of new learning to familiar and practical problems. It is the function of structured mediation in teaching and learning to aid acquisition, comprehension, memory and performance by using appropriate

schemata to enable the assimilation of new experiences and the utilization of existing knowledge.

These appear to be promising developments in the cognitive sciences. As indicated earlier, all of these notions and models are not ready for mass application to the problems of pedagogy. However, some of the findings are sufficiently well established and others are sufficiently confirmed in existing practice to be used to inform current interventions. Given the directions being taken by some of the experimental workers in curriculum and teaching, we can realistically expect that the next generation of interventions in the facilitation of educational development for minority students will reflect at least some of these developments in the cognitive sciences.

PART III

SUMMARY

Our analysis indicates that the field of pre-collegiate and collegiate programs in engineering education for underrepresented minority students is very active and has been relatively effective in increasing the number of black and Hispanic persons who enter the engineering professions. The proportionate growth of minority participation in these professions, when compared to other professions, is outstanding. However, the production of such professionals in relation to the majority population is quite modest and may be absorbing a disproportionate share of the most talented segment of the minority population. It begins to be clear that expansion of the pool from which candidates for the profession are drawn is an essential next step. With respect to the extant preparatory programs for minorities in engineering, we have observed:

1. Considerable unevenness in the quality of conceptualization and design of programs. Some programs reflect very clear conceptions of a view of the problem and an approach to solving it. Others lack such clear vision and appear to be opportunistic, faddish and ritualistic in their program designs. Much of the extant work continues in the traditions of compensatory education with an emphasis on remediation -- "catching up even while trying to keep up."
2. Unevenness in the quality of program delivery. In the few programs for which we were able to do site visits or

where we received detailed program descriptions, we observed carefully executed programs where attention was given to details and sensitivity to psychological, poltical and social factors was demonstrated. Some of these programs are well staffed and appear to give sustained attention to problems of curriculum content, quality of instruction and the monitoring of student progress. In other cases, we find form without substance, understaffed programs, little appreciation for the complexities of student academic development, and little indication of institutional commitment to support of these programs.

3. Inadequate representation and application of the emerging pedagogical knowledge base to the problems at hand. For example, we found very few programs in which faculty were working to understand and apply some of the current knowledge coming from cognitive science and the psychology of subject matter learning. Where concepts from social psychology and the social sciences are being applied, their use is from a colloquial perspective rather than being informed by the scholarly analysis of current research. It appears that many institutions apply a lesser standard in judging the quality of their special services to minority students than in judging their more traditional academic and research work.

4. Contradiction between content mastery, required for entrance to programs of study, and process mastery, required for professional competence. Programs for minorities in engineering are not alone in this criticism. These

paradoxical demands are peculiar to all areas of professional education. We admit persons to study and advance them in professional education largely on the basis of content mastery. Yet, the professional demand is not only for mastery of the knowledge and skills but is for the practical application of knowledge, skill and insight in addressing the processes with which the professional is confronted. The growing attention to process mastery and problem solving competence is movement in the right direction, but is under-emphasized in the program descriptions we have reviewed.

5. Emphasis on the discovery of talent or identification of persons who show that they have already developed abilities. This emphasis is understandable since we know more about teaching able learners than we know about developing academic talent in less able learners. Yet, many of the programs studied do admit students who need academic help if they are to flourish in rigorous studies of mathematics and the sciences. It is here that overemphasis on discovery is dysfunctional. These marginal students need our most resourceful developmental interventions. There is a second aspect to the possible inappropriateness of overemphasizing talent discovery. There may be a limit to the number of traditionally prepared able minority students. It does not make sense that all of our institutions compete for that same pool without first determining whether the pool can be expanded through talent development.

6. Potential conflicts between the mechanisms of expanded minority participation and the mechanisms of leadership development. The programs studied and the field in general have demonstrated that talent search, support services and financial aid have served the purpose of increasing minority participation in engineering. It is not as clear that these strategies are sufficient to serve the equally important purpose of leadership development. In fact, the mechanisms may be in conflict with each other and thus reciprocally counterproductive. Leadership development, for example, may require enrichment intervention of a different order from that necessary for survival in the field. Leadership development may require that we concentrate on fewer students. It may mean that preparation for leadership careers in engineering requires that we intervene earlier and continue interventions long past graduation from the educational institution. It may require that factors in the profession and institutions which employ engineers will have to be made less hostile and more supportive of the advancement of new members for whom race, use of language, and cultural style may be different even while they demonstrate excellence by traditional standards. Our studies so far have not enabled us to say with authority how to intervene on these fronts. It is clear, however, that both the purposes of expanded participation and expanded leadership development must be served. The challenge is to improve our approach to both.

One can see from the descriptive analysis of extant

programs, the experimentation in curriculum and teaching, the affective and motivational interventions, and the emerging applications of cognitive science, that although we have not solved the problems of accelerating the development and participation by minorities in engineering study, we are able to draw conclusions concerning directions which show promise for this work. Among the more salient are the following:

1. Exposure early in the life of the child (ages 5 or 6 to 12 years) to rewarding hands-on experiences in mathematics, science and technology with ample opportunities for exploring, discovering, and questioning relationships between concepts and materials.

2. Early and continually mediated learning experiences in which learners are guided in identifying relevant schemata, salient and distinguishing features, lawful relationships, taxonomic indicators and other aids to information processing which also serve to maintain a balance between challenge and frustration in learning. Promising models may be seen in the statewide MESA program in California and MEAP at Purdue but both may not start at a sufficiently early age and mediation may be insufficiently implemented.

3. Obvious as it may sound, exposure to well-structured, relevant experiential and theoretical course work is increasingly recognized as an essential in students' academic development. Such exposure is certainly not a sufficient condition but we now recognize that it is an essential condition which is not experienced by large

numbers of minority students. Moreover, it is clear that it can be difficult for schools to provide effective coursework to minority students in areas (e. g., math and science) that are essential for engineering. The best models may be observed in the Lockhead work at University of Massachusetts, the Lopez work at Columbia University and at the Kinkaid School in Houston.

4. Incidental or directed learning experiences designed to enhance cognitive competence such as problem solving, critical thinking, meta-cognition, knowledge acquisition strategies and the executive management of mental processes. Examples of beginning efforts at implementing these ideas may be observed in the work of Henderson et al., at CCNY, and Gordon, Sternberg and Thomas at Yale.

5. Targeted instruction and remediation where teaching and tutoring are informed by psychoeducational assessments which enable the customization of learning experiences to meet the specific and general needs of learners. This model was first developed by Monroe at Miles College.

6. Socialization to the demands and rewards of academic and professional life appears to be essential to the development of students whose natural environments have not provided such socialization experiences. Young people who are the first generation of their family to seriously pursue academic work and higher education have had fewer opportunities to learn the demands and routines of rigorous academic work. See the work of Knowles at Rensselaer and Adams at Notre Dame.

7. Counseling and guidance services beginning early in the school career and continuing at least through college, which a) encourage awareness of career options; b) enable students to make informed and considered decisions; c) enable the exercise of choice through adequate preparation and opportunity; and d) make available the psychological and social supports which are essential to sustained effort in populations for which serious academic pursuit may be an alien experience. The Southeastern Consortium for Minorities in Engineering has incorporated elements of this conception in its pre-collegiate program.

8. Financial assistance and funding for students and programs is not a sufficient condition for success but is clearly an essential requirement. Few members of the targeted populationscan afford the cost of an engineering education and the idea of a $20,000-$40,000 indebtedness at the beginning of one's career can hardly be encouraging to the people we want to attract. Several programs have interesting, if not attractive, financial aid packages. Fewer programs have adequate and stable funding which enable them to be institutionalized and fully integrated into the mainstream functions of the institution. Examples of programs where funding appears to be stable include Cornell, Georgia Tech, MESA, Rensselaer, University of Tennessee and University of Texas (Austin).

IMPLICATIONS FOR RESEARCH AND DEVELOPMENT

This study, which is based upon a bibliographic and mail survey, is limited in its coverage of relevant programs and activities, but is even more limited in its in vivo analysis of the nature and functional characteristics of current practice. Very little on-site cases analysis was done. If we are to fully understand what is happening in this field, how good it is and why, and how we can improve what we do, much more inclusive study and intensive analysis of selected cases and data are required. In addition, we need a much more sophisticated data base with which to work. We have not found detailed information concerning program implementation -- what treatments are actually delivered to students and how are these treatments utilized? We have not found systematic data on numbers and characteristics (demographic and functional) of students admitted to programs, alongside retention and graduation data -- actually who is being admitted and who is being graduated? We did not find detailed data on what happens to students when they leave our programs through attrition or graduation. We were able to collect little information concerning the developmental course of attitudinal, academic or career development in underrepresented minority students in engineering. We suspect that much of these data could be easily collected were a system in place for their collection and analysis. Some of these data probes will, of course, require new and additional effort. However, the data available to us, augmented by the considered judgments of an informed panel of advisors (see Appendix B) may be sufficient for

us to conclude that more study of what is extant is insufficient. The unanswered questions seem to relate more to the nature of the need, the mission to be accomplished, and what should be done. These and other questions require that we take stock of the past 15 years of experience and make projections for the future. Future policy decisions in engineering personnel production will require that we know (1) what the nation's need for engineers and engineering-literate people will be over the next thirty years; (2) what range of competences and skills will be required; (3) from what population pools is there a reasonable chance that we can develop such talent; (4) what predictors are available for the identification of minority youth who are members of those pools or who can be brought into those pools; (5) how effective are extant programs in producing the needed competencies and skills; and (6) how do we enable institutions and students to do those things which will be needed but which, as yet, they are not doing.

There are other research questions which adhere to program and practice decisions. At the level of current practice, there are obviously some things we do in this field that work better than others. Maybe we have developed sufficient models and practices to begin controlled comparative studies to determine empirically which practices produce specifiable results. Our existing treatments are rather generic. Such studies could help us to identify patterns of intervention as the treatments of choice for specific developmental problems. The range of achievements in the minority population of engineering students and professionals is quite broad. Yet, the persons admitted to

study in the field generlly represent a select population. The study of outliers in this population, i.e., highly successful, marginal and unsuccessful persons, could contribute to our understanding of personal, processual and situational correlates of success and failure for minorities in engineering and engineering education. We have reported isolated efforts at bridging curriculum and teaching, educational psychology and cognitive science to more effectively apply this knowledge base to the problems of engineering education and pedagogy in general. Such work should be encouraged, and could form the scientific basis for pedagogy, just as comparable expansions in our knowledge of the biological and social sciences, the physical sciences and public health were integrated to form the scientific basis for medicine. Conceptual studies which build upon the exciting empirical findings from cognitive science might inform the next generation of interventions in the educational development of populations at risk of underdevelopment. There is a host of smaller ideas and practical studies which should be undertaken. As examples consider, 1) differential approaches to tutoring; 2) application of instrumental intellectual enchancement strategies; 3) peer tutoring and team learning; 4) instruction through computer simulation; 5) computer managed adaptive and interactive instruction. The list is almost endless but an experimental approach to work in engineering education will require that we draw into the field professionals from other disciplines. A few years ago a prominent midwestern medical college added a division of pedagogical studies charged with

responsibility to study and hopefully improve instruction and learning in medicine. If we are concerned about the maintenance of excellence in engineering education and also concerned about broadening the pool and kinds of talent we invite to participate, we may have to begin to apply engineering competence to the design and implementation of education for this profession.

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APPENDIX A

BRIEF DESCRIPTIONS OF RESPONDING PROGRAMS

AUBURN UNIVERSITY

MINORITY INTRODUCTION TO ENGINEERING (MITE)

The Auburn University MITE Program is designed to give minority high school students with outstanding academic records an opportunity to become familiar with various fields of engineering, employment opportunities, and exposure to university life. It is a residential program, with students living in dormitories and eating in university cafeterias.

While the MITE program is intended to attract minority students to engineering, the program at Auburn also has a strong academic component. Approximately 31 hours of classroom instruction are devoted to mathematics and computer science and about 18 hours to laboratory experiences in the various engineering labs. Other activities include seminars with representatives from companies that participate in the cooperative education programs (these usually involve minority co-op students); an industry panel discussion in which minority engineers from various companies speak on "Why Engineering"; presentations by representatives of the various ROTC units at Auburn; and information about student affairs such as financial aid and admissions requirements. Field trips to local industries are conducted during each two-week session.

Target Population

Rising high school seniors; mostly blacks, Hispanic, Native American (83-84); most from public school; total 85-86: 23. Must be minority high school rising senior, completed 3 years of math with interest in engineering, high academic standing.

Funds

Total 85-86 budget: $21,450.

Outcomes

Response to our survey is about 70% of those almost 100% attended college, about 70% of respondees in engineering/science/math. About 65% of those attending in 1979 graduated from college; 46% in engineering/science/math. Most attend state universities.

Evaluation

Participants complete a critique form at the end of the program.

CASE WESTERN RESERVE UNIVERSITY

MINORITY ENGINEERING PROGRAMS

The three programs combined offer a very comprehensive approach to preparing minority youth for engineering careers. Also, the core staff is experienced and very stable. The Director and Coordinator have been with the programs for nearly ten years. Although we constantly evaluate and attempt to improve our programs there is a great deal of continuity and consistency in the services we provide our students. In addition, we have been able to closely monitor our students' progress. We have maintained accurate statistics, which provide a good, objective measure of our programs' effectiveness.

CASE EARLY EXPOSURE TO ENGINEERING FOR MINORITY STUDENTS (CE^3MS)

The Case Early Exposure to Engineering for Minority Students is designed to enhance the academic preparation and stimulate the analytic thinking of ninth and tenth graders interested in engineering. The five week CE^3MS summer session consists of classes in mathematics, chemistry, and computer science. Lectures and demonstrations conducted by professional engineers and Case faculty members, hands-on laboratory experiences, career exploration workshops and field trips are also included. Later in the school year students are invited back to Case for reinforcement programs which keep students motivated and aware of courses they should be taking in preparation for admission into engineering schools.

Target Population

Students who have completed 9th or 10th grade; mostly blacks, 1 Asian American (indicate Hispanics and Native Americans); total 85-86:52, public school (74.5%), private (4.5%), parochial (21%).

Funds

Total 85-86 budget: $10,000 ($7,000 external)

Outcomes

No data

Evaluation

All participants evaluate their instructors and the overall program at the conclusion of the summer session.

MINORITY ENGINEERS INDUSTRIAL OPPORTUNITY PROGRAM (MEIOP) PRE-COLLEGE PHASE

The Minority Engineers Industrial Opportunity Program is divided into two phases, one for high school students and one for Case undergraduates. The pre-college phase begins with a five-week summer session for students who have completed the 11th grade and who have indicated an interest in science and engineering. The summer session consists of intensive academic preparation in mathematics, physics, and communication skills. Engineering and physics laboratory work, field trips to local industrial and research facilities, and counseling (academic, career, and personal) area also provided. Classes meet from nine to five, Monday through Friday.

Students who successfully complete the summer experience are invited to participate in a Saturday program that begins the following September and continues throughout the school year. Classes focus on further development of the student's math and communication skills and preparation for college entrance exams. One Saturday morning is devoted entirely to a workshop on the college application process. Information about several engineering schools is provided and several hints and suggestions for completing college application forms are discussed. During the second semester, Saturday sessions cover a wide variety of topics including financial aid (for students and their parents), study skills and assertiveness.

Target Population

Students who have completed the 11th grade; black, Hispanic and Native American.

Funds

Total budget 85-86 $10,000

Outcomes

College matriculation rate 97%, 72% in engineering/science/math. So far we have complete data only on those students who have attended Case. We hope to do a more comprehensive follow-up study this year. Colleges attended range from extremely selective to moderately selective.

Evaluation

All participants evaluate their instructors and overall program at the conclusion of the program.

MEIOP - UNDERGRADUATE PHASE

The undergraduate phase of MEIOP is open to all minority students who attend Case Institute of Technology (CIT). MEIOP provides these students with an academic support program, which consists of mandatory study sessions for underclassmen, study skills workshops, counseling and tutoring. Through its industrial sponsors, the program also offers participants financial

assistance and an opportunity for summer employment. We attempt to place each student with an industrial sponsor during his freshman year (ideally to continue with that same sponsor every summer while in college). The program is structured so that in addition to being paid for their summer work, the students receive partial tuition grants ($1,000 for each of their first two years at Case and $2,000 for each of the remaining years) from their sponsors.

In the last three years MEIOP has implemented a number of additional activities specifically for freshmen to promote retention. During the summer prior to their enrollment in an engineering curriculum at CIT, minority students are invited to participate in a six-week, residential pre-freshman summer session. We offer introductory classes in mathematics, chemistry, and computer science. The goal of the pre-freshman program is to facilitate participants' transition from high school and home to college and dormitory living. To better prepare students for the workload at Case, a series of study skills and time management workshops are provided. Other activities (field trips, guest speakers, etc) are included to motivate the students and enhance their interest in engineering.

Target Population

Undergraduate students; black, Hispanic, Asian American, Native Americans.

Funds

Total budget 85-86: $120,560

Outcomes

No data

Evaluation

Our undergraduate students regularly evaluate various program components (pre-freshman summer session, MEIOP freshman orientation activities, study laboratories, tutoring). No formal report has been prepared. We monitor the progress of our undergraduates and use our graduation rates as an overall measure of our effectiveness.

CHICAGO AREA PRE-COLLEGE ENGINEERING PROGRAM (CAPCEP)

The objectives of the CAPCEP, a non-profit corporation, is to improve math and science education in Chicago area public schools. The overall mission is to increase the number of minorities entering the career fields of engineering and science.

The Program provides a comprehensive in-service training for 7th and 8th grade math and science teachers to strengthen their

skills in math and science and classroom management. Teachers attend full-day training sessions two times a month. Training is conducted at National College of Education (math) and Illinois Institute of Technology (science). Training is accompanied by school visits which needs assessment and program reviews are conducted by math and science educators in concert with school principals and CAPCEP teachers (2 visits per school per year).

The students of the CAPCEP teachers participate in the program by attending an annual conference. In attending, they are able to compete in academic contests and engineering design competitions. The math and science appreciation program includes problem solving exercises, project mentoring by engineers and technicians who use math and science in their work, career counseling and academic competitions. The students are monitored throughout their high school experience to determine whether they are enrolling in the appropriate math and science courses. Field trips to engineering sites are facilitated.

On-going support is provided to CAPCEP teachers via involvement in local, regional and national professional activities. The Program develops high school curricula which integrate math and science instruction and develops a math and science resource data bank, published as a teacher catalog, to help enrich classroom instruction.

CAPCEP addresses a most critical need. Strengthening the academic background and effectiveness of classroom teachers serves to increase the pool of students eligible to pursue careers in engineering and science. We work within the system with top level administrative officials, principals, teachers and students. A comprehensive approach is used to ensure significant improvement in math and science education within the Chicago public school system.

Target Population

Students and teachers in grades 7-12; blacks, Puerto Ricans, Chicanos, Native Americans and Asian Americans. All from public high school.

Funds

Total budget 85-86 - $85,000

Outcomes

No data

Evaluation

We pre and post test the elementary school teachers. The teachers also complete a program evaluation.

UNIVERSITY OF CINCINNATI

MINORITY RESEARCH APPRENTICESHIP PROGRAM (MRAP)/US EPA

The US EPA University of Cincinnati Minority Research Apprenticeship Program aims to stimulate and motivate capable minority students toward technical careers. Apprentices grow in their abilities to work in scientifically based environment and successfully adjust to the vast difference between what they had perceived and what they had experienced. They better clarify their career goals - focus upon and identify a career direction. After completing the summer program, learned procedures and processes, sharpened mathematical and technical writing skills, learned about major environmental problems.

MRAP is essentially a summer working experience. Components of the program include: mentors, labs, field trips, job placement, apprenticeship papers (written during the program) and "enrichment activities" (designed to expose the research apprentices to various occupation opportunities in science and engineering, held one day a week). The emphasis is on engineering sciences. The summer program ends with a recognition program. Apprentices receive pay for their work.

In 1980, as a result of a White House directive, the Minority Research Apprenticeship Programs were established in the federal agencies. The US Environmental Protection Agency funded seven programs at various research facilities throughout the country. Currently the US/EPA Minority Research Apprenticeship Program is the only viable program. Our uniqueness comes from various factors - the mentorship of the EPA supervisors, the role model effect to the interaction between the engineering students and apprentices, the Friday enrichment programs the chance to earn and learn, etc.

Target Population

Students grades 10, 11, 12; minority mostly from public school (136) (26 from parochial)

Funds

Total 85-86 $82,359

Outcomes

No data

Evaluation

Student and mentor evaluation (Final Report).

CITY COLLEGE OF NEW YORK

The City College SEEK Program, a program for students with special academic and economic needs, develops MAPES: Minority Assistance Program in Engineering and Science. This is a highly structured basic skills program for first semester students which combines instruction in basic skills and an introduction to the sciences, with counseling and programs which expose students to the world of engineering, science and achitecture. Students eligible to participate in MAPES are those who need only one semester of remediation in reading and writing and no more than three semesters in mathematics.

The long-range goal of MAPES is to increase retention rates and thereby increase the number of minority students who become engineers, scientists and architects. Its immediate goals are to reduce the number of semesters that students spend in remedial course work, to introduce the students to the pace and self discipline required by mathematics and related science courses, to encourage students to work together to support one another in their scholastic efforts, and to motivate them to succeed in their pursuit of challenging academic goals.

The curriculum includes courses in reading and study skills, basic writing with an emphasis on the sciences, speech and mathematics. In addition the curriculum includes a science course specifically designed for the program as a non-mathematical introduction to selected topics in physics. Counseling is an essential component of MAPES. An intensive one week "mini-semester" of combined orientation, instruction and practicum is provided by the Brookhaven National Laboratory to MAPES students during the spring recess. Guest speakers (role models) include upper classmen and faculty in engineering, the sciences and architecture, and representatives from industry.

Target Population

The program serves first-term college freshmen. Men and women, mostly black and Hispanic, a few Asian Americans; practically all from public school.

Funding

All institutional

No outcome or evaluation information

SELECT PROGRAM IN SCIENCE AND ENGINEERING (SPISE)

Inititated as a program to motivate and prepare educationally disadvantaged high school students, the Select Program in Science and Engineering at City College (CUNY) concentrates on tenth grade students from eight New York City high schools. The major aims of the program are:

O to develop teaching materials and methods that would attract and hold a student's interest in the physical sciences, engineering and mathematics
O to convince the students that mathematics is the key to careers in science and engineering
O to provide laboratory experiences that would attract students while emphasizing the necessity for the mastery of mathematics
O to provide personal and career counseling for the students

SPISE now has 18 participating high schools, two groups of nine, participating on an alternating basis one calendar year at a time. This rotation permits each school to involve each of their sophomore classes in the Program. With each rotation of participating high schools, workshop sessions for participating staff are held. These are designed to review and revise curriculum and materials that were developed by prior program staff. Each semester 265 high school students attend a specially designed program intended on motivating and preparing economically disadvantaged youngsters for careers in science and engineering. Each week students are offered a science or engineering laboratory experience and a mathematics class. After lunch (provided free of cost) students are presented with a career lecture (speakers usually provided by various corporations), other motivating large group activities, or a counseling session.

Target Population

10th grade students; black, Hispanic, Asian American; low income (using NYC Board of Education guidelines); all public school. Total 85-86: 500 approx.

Funds

Total 85-86 budget $110,000 (approx), approx $85K from private sector, $25K from NYC Board of education.

Outcomes

No real data: "Extremely high" college matriculation rates. Wide range of colleges.

Evaluation

Student opinion questionnaire, anonymous student evaluation questionnaire, staff evaluation questionnaire.

COLUMBIA UNIVERSITY SCHOOL OF ENGINEERING AND APPLIED SCIENCES

COMPREHENSIVE MATH AND SCIENCE PROGRAM (CMSP)

The Comprehensive Math and Science Program is a field based research and development program that was initiated in 1974 under

a National Science Foundation grant in response to the severe underrepresentation of black, Hispanic and American Indian students in the Nation's engineering colleges. Operating under the premise that enrollment and subsequent achievement in engineering and science based college study is highly dependent on a prospective student's strong mathematical background, the CMSP has focused its research and development work in high schools on:

O creating and test implementing models of mathematics curriculum and instruction aimed at increasing the pool of students who enroll and achieve in four years of high school mathematics study
O organizing and establishing joint high school/college/industry programs to introduce and heighten student awareness of science and engineering careers and the prerequisites for engineering and science based college study.

MATH ACHIEVEMENT MODEL

The goals of the Math Achievement Model are to develop and test implement a model system of mathematics curriculum and instruction that significantly increases the pool of students at participating schools that enroll and achieve in a 4-year sequence of college preparatory mathematics. Incoming students at participating schools are automatically enrolled in CMSP math achievement model.

(To our knowledge) the CMSP is the only research and development project doing field based work that is aimed at the complete restructuring of mathematics programs at participating schools. The clear distinction of the CMSP project efforts are: that student participation is non-selective (no reference to prior math achievement or background); the CMSP performs its development work directly in the schools during the regular school day every day during the academic year and for 5 weeks during the summer. The model design allows incoming 9th year students to build a strong foundation for Algebra and Geometry by complementing math courses with science topics and computer applications. The model curriculum is highly structured and emphasizes problem solving in a complementary math course format. Students are selected at random.

Target Population

Students grades 9-12; black, Hispanic, Asian American; all from public school; total 3550 (85-86).

Funds

Total budget 85-86 $250,000 ($240,000 from external funding). Local industry plus cost share for instructional and coordination expense by the New York City Board of Education.

Outcomes

Student participants in the Math Achievement Model are currently juniors and not applicable.

Evaluation

A yearly report is presented to the CMSP advisory panel, indicating progress in the development of the CMSP Math Achievement Model. (Attached)

COMPUTER SCIENCE MAJOR

The goal of Columbia's Computer Science Major is to develop and test implement a model major offering at Brooklyn Technical High School. The Computer Science Major is aimed at providing students with a broad range of skills and experiences in working with personal computer systems. The major theme will be problem solving in a variety of design and applications projects. The curriculum is organized in a sequence which allows students to build a knowledge base in several programming languages including BASIC, ASSEMBLY, COMAL, PASCAL, FORTRAN, LOGO AND COBOL. Classroom activity will be heavily hands-on utilizing Commodore, Apple IIE and IBM personal computers. The Computer Science Major will encompass coursework over a 4 semester period starting in the fall term of the 11th grade. The major will consist of a contiguous block of 7 courses plus a 1 term/2 period block for student team projects.

This program is the only program we know of that is given in a high school that allows a student to do advanced work in computer science as a complete major program offering involving 7 closely related courses and an individual student project.

Target Population

Students in 11th and 12th grades; black and Hispanic; all from public school; total 55 (84-85).

Funds

Total budget 85-86 $55,000

Outcomes

College Matriculation rate: 90%, engineering/science/math - 80%. Data not available for college graduation rates, 1st cycle of students currently enrolled as college freshmen. Range of colleges include: RPI, Baruch, Cornell, Cooper Union.

Evaluation

No data but formal survey course questionnaires are given to students to obtain feedback on the program.

CAREER SEMINARS FOR ENGINEERING AND TECHNOLOGY

Columbia University's CMSP Career Seminars program aims to develop and implement a model program to increase student awareness of the prerequisites for college study in engineering and in careers in engineering and technology. The Seminars on Careers in Engineering, Technology and Computer Science is a series of presentations and college visitations designed to acquaint and inform high school juniors with the world of technology and the nature of college studies leading to technical and professional careers. The Career Seminars are offered at the 11th grade.

Only students who have completed algebra and geometry coursework and who are currently enrolled in 11th year math are invited to participate in the seminars. The topics covered in the seminars include: Engineering and Technology College Programs, the Technology Degree and Its Relationship to Engineering, Computer Science College Programs, College Applications and Admissions, and Financial Aid. Description of various technologies included: Communications, Aerospace, Chemical and Computers. Presentation of these topics is made jointly by high school, college and industry staff participating in the seminar program. The seminars are conducted over three to five successive Fridays and Saturdays during the spring term. The program has been conducted at Brooklyn Tech and will be implemented at 7 other high schools.

40+ engineering colleges are in attendance at the college fair held at Brooklyn Technical High School. It is the largest such college fair for minority students in the country attracting more than 500 students twice a year. The Career Seminars themselves offer participating schools an opportunity to work together as a network in which small pools of students at each of the schools are gathered to become a large pool of substantive size - all of whom are on a college track.

Target Population

Students from grades 11 and 12; black and Hispanic; all from public school, total 610 (85-86). Acceptance based on performance on Regents Math Examinations.

Funds

Total budget $78,000 in 85-86

Outcomes

College matriculation rate: 80%, engineering/science/math: 70%. Graduation data: students enroll in too many colleges to track them efficiently. Enroll in local technical community colleges such as Queensboro CC to highly competitive colleges and universities such as Columbia, Cornell and RPI.

Evaluation

A yearly report is submitted to the NYC Board of Education.

CORNELL UNIVERSITY COLLEGE OF ENGINEERING

MINORITY INTRODUCTION TO ENGINEERING (MITE)

The purpose of the Minority Introduction to Engineering Program is to acquaint minority high school students with engineering at Cornell University and to inform them about the general requirements and demands of undergraduate study in engineering. The Cornell MITE specifically aims to interest high school students in Engineering, to expose them to all the disciplines in a week's time and to encourage them to consider Cornell as an option.

The MITE Program is designed to give high school juniors a broad but accurate experience of the study of engineering at Cornell. Participants will experience some aspects of "life at Cornell" by living in supervised residence halls, eating in campus dining hall units and interacting with fellow students from all over the world. The program format includes daily participation in introductory advanced math classes, followed by lectures, demonstrations, experiments and tours highlighting the specific engineering fields. Professors and chairpersons from the various departments will speak and answer questions relating to study in and careers in the different engineering disciplines - with special attention to the concerns of minority members.

The Program will also include discussions of Cornell's admissions and financial aid procedures, lectures by minority engineers, and will culminate with a picnic, bowling and an awards presentation. Students get exposed to non-traditional geological sciences and materials sciences. Also through this program the students learn that they can do computer science from any discipline.

Target Population

High school post-juniors; black, Hispanic, Asian, Native American; 80% from public school; 85-86 total:30. Requirements: complete junior year of high school; minimum "B" average, performance in college prep courses (math, science), participation in pre-engineering activities, standardized test scores and interest and motivation.

Funding

Total 85-86 budget: $12,000 (some corporate support).

Outcomes

350 students over 10 years; all but 1 have gone to college, mostly in engineering; 3 MITES are graduating from Cornell.

Evaluation

Informal evaluation: very successful in motivating students.

PRE-FRESHMAN SUMMER PROGRAM

Cornell's Pre-freshman Summer Program began in 1971 for students accepted at Cornell. The purpose of the program is to prepare students for engineering, to orient them to various programs. This is a six week program in which the pre-freshmen share dorms with other engineering students and establish a community, study habits and rapport.

The pre-freshman program offers pre-college prep and orientation, special admissions procedures, all types of counseling, tutoring and remedial instruction; 2 developmental courses, chemistry and math and a computer science course. Students are also taken on site visits. The program includes a 1 day session (dissemination of materials, discussion, etc.) for college faculty and counselors involved. The program tries to provide both cognitive and community development in the students.

Target Population

Pre-freshmen accepted at Cornell; mostly black and Hispanic; majority from public school; 85-86 total: 35. Mandatory for students designated by admissions. Use HEOP to identify needy children; channel them into engineering. Must be minority.

Funding

Total 85-86 budget: $350,000 campus wide from Provost's Office at Cornell.

Outcomes

35% over the years are graduating and going on to graduate school. Minority retention rate is better than the overall retention rate.

Evaluation

Informal procedure, question students about how program went. Generally successful.

DENVER EDUCATIONAL ENTRY TO ENERGY PROGRAM (DEEP)

The Denver Educational Entry to Energy Program of the Denver Public Schools functions to provide an enrichment program for middle school and high school students to motivate academic achievement and encourage educational pursuits in the areas of science and math; to assist students in attaining the skills necessary to be successful candidates for entering scientific fields such as engineering, medicine, geology and other

scientific and related technical professions. While the program is open to all students of the Denver Public Schools, special consideration will be given to female and minority students to maximize their potential for achievement in the areas of mathematics, science and english.

The design of the DEEP project is based on components from PRIME (Philadelphia), TAME (Texas) and FAME (Wilmington, Delaware). The project's goals are:

O to identify, counsel and train middle school and senior high students wh will enroll in college and succeed in pursuing a career in the scientific and technical field
O to develop in students positive self-esteem and self-direction
O to improve the academic achievements of students enrolled in the project.

Program components include an advisement program, student-teacher-parent agreements (clarifies individual responsibilities), study skills program, curriculum (curriculum from the State University of New York at Stony Brook has been incorporated along with existing mathematics, science and communication curriculum of the District), experience-based activities (field trips and observation experiences at business and industrial sites), and community involvement (role models from the business community plus financial support).

Target Population

Students from grades 7-12; black, Hispanic, Asian American, Native American; all from public school (total 309).

Funds

Total budget 85-86 $96,732 - some financial and mentoring support from the business and professional community.

Outcome

At present not oucomes data; first high school class graduated in the spring of 1985.

Evaluation

Student, advisor and parent questionnaires are sent out at the end of the school year (last year's report not available).

FORUM TO ADVANCE MINORITIES IN ENGINEERING (FAME)

FAME is the Forum to Advance Minorities in Engineering, Inc. It started in December 1976 and has grown to be a broadbased community-wide program in the greater Wilmington area. The program brings school, community and industry together. Its purpose is to increase the number of minority students in the

Wilmington area preparing for engineering study in college. The effort starts with local youth in their middle school years and extends through college (7-12 grades).

FAME's objectives are:
O Establish local action programs in support of the goals of the National Action Council on Minorities in Engineering (NACME). Those goals are to achieve population parity of minority engineering freshmen by 1982 and minority engineering graduates by 1987.
O Motivate students to pursue and succeed in science and math required for acceptance in colleges of engineering.
O Expose students to cultural, academic and industrial environments.
O Provide minority engineering and technical role models.
O Develop a broad-based, long-term community commitment.

FAME involves students in motivational awareness and pre-engineering classroom readiness activites. It provides an extremely comprehensive program that now includes not only school year activities but summer enrichment as well. Summer activities include learning more about science, math and communicating ideas; touring industrial sites and meeting engineers at work or participating in a project working closely with professional engineers. During the 11th grade, students spend six weeks living on the campus of the University of Delaware participating in science laboratory activities and some mahematics. In the 12th grade students spend six weeks at the University of Delaware and study advanced mathematics and physics. High school graduates may spend the summer employed by local industries such as Du Pont, Hercules, or Hewlett-Packard. The FAME Program includes meeting with parents and community people to keep them informed of what FAME is doing and what financial possiblities exist.

Target Population

Students 7-12th grades, summer employment for undergraduates and job placement for graduates. Mostly blacks, a few Hispanics and Asian American (250). About 50% from public school.

Funding

About $100,000 per year from local industries.

Outcomes

Almost 100% of students matriculate into colleges (major colleges and universities throughout the country); about 80% in engineering, science and math fields.

Evaluation

The program is evaluated annually by the Education Committee. No report is included.

GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF MINORITY EDUCATIONAL DEVELOPMENT (OMED)

The Office of Minority educational Development (OMED), created in 1979 serves as an important liaison between minority students and Georgia Tech's administration. OMED works closely with Tech's four colletes - Architecture, Engineering, Management, Science and Liberal Studies - its administration and student support services and its minority faculty, student organizations and alumni. Dedicated to the social and academic success of minority students at Tech, OMED provides tutors, counseling and many academic and professional programs to assist these students from their initial enrollment until their graduation. The office also maintains close contact with the various student organizations.

A major program sponsored by OMED is Challenge. CHALLENGE is a six week, non-credit, pre-college program designed to give minority students a head start to success at Tech. The courses within this program are taught primarily by members of Georgia Tech's faculty. CHALLENGE bridges the gap for minority students between high school and college and focuses on strengthening their academic background in problem solving and study skills. It began in 1980.

OMED provides recruitment, academic support, retention and graduation. OMED keeps a "warning probation" list and contacts those students individually to offer help. The early warning comes from student assistants. OMED also provides lists of seniors by ethnicity, sex and standing to companies. It is a very comprehensive program. Most of the components of the retention program need faculty involvment, but have been very successful. Tech has a dual degree program with Atlanta University Center Schools: degree in science from Atlanta, then 1 year at Tech. OMED has a learning center. OMED diagnoses problem areas for students. The peer counseling program is critical. Incoming freshmen are matched with upperclassmen by major. Students can drop in or make an appointment for the tutoring program.

Through other affiliated programs at Georgia Tech students from 7th grade to graduate level are reached: SECME, MITE, GEM (graduates) and OMED college level and Bridge.

Target Population

"Blacks, Hispanics, Asians and Indians;" from Georgia and the Southeast; total - 1129 (approx. 654 black, 217 Hispanic).

Funding

1984-85 budget $224,125 ($139,000 state funds, 30% Georgia Tech Foundations, 20% industry gifts).

Outcomes

Compared to 1979 Data base on minority success.

Evaluation

Self-evaluation, keep own records.

MINORITY INTRODUCTION TO ENGINEERING (MITE)

Since 1974, the College of Engineering has offered the Minority Introduction to Engineering (MITE), a program designed to motivate rising senior minority students to consider careers in engineering. Two one-week sessions of MITE are held each summer for approximately 140 participants from 14 states and Puerto Rico. Activities featured in the MITE program include film and slide presentations, field trips to local industries, participation in engineering-related experiments, visits to Tech's engineering schools, panel discussions with current engineering students at Tech, a mini-career fair, and workshops with industrial representatives.

Unlike many, Georgia Tech's MITE Program uses an "Introduction" format. The MITE administrators carefully schedule an intensive week of engineering related activites with a minimal amount of "free time." Rather than attend academic classes (such as mathematics or science) participants are exposed to a variety of engineering applications such as mass urban rapid transit technology, chemical mixture, storage and shipment, aircraft construction and fiber optics. Through audio-vidual presentations, lectures, field trips, panel discussions, etc., MITE students have a unique opportunity to interact with Georgia Tech students, faculty and staff as well as with representatives from industries that employ engineers.

Addresses "whole person." Aims to build community feelings and reduce isolation of minority students. Provides hands-on experience by dividing students into teams for activites like egg and parachute contest, mousetrap cars, etc. Students are given "T" shirts as badges and souvenirs.

Also part of the Special Programs at the School of Engineering are: GEM (National consortium for Graduate Degrees for Minorities in Engineering), FEW (the Freshman Engineering Workshop), JETS/NEAS (National Engineering Aptitude Search/Junior Engineering Technical Society testing program), STEP (Students at Tech Expand your Potential) and women's programs.

Target Population

High school seniors; black, Hispanic, a few Native Americans; public school; 55/45% m/f; mostly from east of the Mississippi, mostly first generation college, very few from families with an

engineer. Total 84-85: 135. Asian Americans not considered minority by MITE. Academic requirements.

Funding

Total budget 84-85: $51,282 a mix of institutional and corporate (about 7% inst.). Details not released.

Outcomes

Matriculation rates: 85% to Engineering, 10% science, 5% professional. 50% college graduation.

Evaluation

Send letters to participants to get their evaluations. One year later they send letters to parents to find out where students went. (Attached)

SOUTHEASTERN CONSORTIUM FOR MINORITIES IN ENGINEERING (SECME)

The Southeast Consoritum for Minorities in Engineering, Inc. (SECME) is made up of the engineering colleges of 23 southeastern universities and 45 companies and other employers of engineers. SECME is dedicated to increasing the number of minorities in engineering professions. SECME operates in local school systems at the pre-college level and encourages academic excellence through a variety of enriching activities and by relating science and mathematics to the real world. In many schools, certain students are selected as a SECME student. In other cases, an entire class may be designated as a SECME class. The program usually involves field competition incentives and awards. A special high school gudiance counselor helps SECME students develop an awareness of opportunities in engineering, technology, and science and advises them on educational requirements and scholarship possibilities at the high school and college levels. In addition, the counselor helps the student make career-oriented decisions, which may deal with educational needs, and even future business trends. Students are also encouraged to take advanced courses in mathematics, science and language arts. Many times, community resources such as local industry, professional and parent groups are used to provide motivation and support.

SECME was organized in 1975 and is one of the most successful programs in the national minorities in engineering effort. One hundred and seventy secondary schools in 60 school systems currently have active SECME programs. Of these programs, 101 have been operating for five years or more. A school system becomes affiliated with SECME following its identification and recommendation by the area university. The program initiation process includes the submission of proposal for membership, a written endorsement from the area SECME member university and signed statements of commitment to the goals of SECME from the Superintendent, program director and principal. The school

system proposal must also indicate local matching funds to be used for SECME school program support.

SECME students are identified as early as the sixth grade (but not later than the ninth grade) from standardized test scores, classroom performance, teacher recommendation, math/science aptitude, related club and co-curricular activity participation or expressed interest in engineering related fields of study. Major methods of operation include: teacher training, leadership workshops, curriculum enrichment, career information, consistent long term, systems management.

SECME is unique in the minorities engineering effort because one of its many areas of focus is teacher training. The key to the effectiveness of the SECME program is the cadre of SECME teachers who provide instruction, encouragement and guidance to SECME students as they go through their secondary school training. The monitoring of school and student activity is a vital part of the SECME program as well. The SECME team plays an important role in the data collection by gathering information on each participating student.

Target Population

Students grades 6-12, moving into colleges; 59% women, 96-97% black, all from public school; total:15,000.

Funding

Total 85-6 budget: $450,000-500,000. No cost to students; teachers pay $25 for summer institute (SECME pays for one teacher to attend from each school, extra teachers must pay). Operations for SECME school programs are jointly supported by the school system, the area university and SECME. The school system purchases the curriculum materials, provides microcomputers as teaching aids and supports inservice training workshops for SECME team members. Additional support comes from the area SECME engineering college which provides an engineering faculty consultant. SECME also provides full scholarships for teachers and counselors who attend the Summer Institute as well as the expenses of the school system program directors who attend special workshops.

Outcomes

Working with ETS to do statistical analysis. Preliminary analysis in 1985 of 2,300 who graduated from high school, 86% plan to continue their education; 41% in engineering, math, sciences. Too early for graduation information.

Evaluation

No external evaluation, internal (See Annual Report).

GOLDEN CRESCENT ALLIANCE FOR MINORITIES IN ENGINEERING

The Golden Crescent Alliance for Minorities in Engineering is sponsored by a joint venture by Union Carbide, ALCOA, DuPont, SOHIO, local school systems. Our goal is to increase the awareness of minority students to the opportunities avaliable to them in the field of engineering. In addition, to increase awareness, our program strives to prepare our students educationally for the rigors of a college engineering curriculum.

Every student must attend the summer sessions and 75% of the monthly meetings. The culmination of our six week summer program (enrichment instruction 3 hours daily) is a Science Exposition. Our students break down into groups of 3 or 4 and work with a local engineer to develop an Expo project. The students spend about 2 months in preparation for the Expo. This event has received media attention both locally and on the state level.

The Golden Crescent Alliance is a member of the Texas Alliance for Minorities in Engineering (TAME). In 14 communities across Texas, TAME works to promote engineering as a career among minority students and their families. Each local chapter organizes the volunteered resources of nearby industries, public schools, colleges and community groups to increase interest in the engineering and scientific fields. Programs include career conferences; summer jobs in sponsor companies; summer community college scholarships; campus, plant and NASA tours; direct classroom involvement by local members in engineering fields; development and definition of pre-engineering curricula; personal assistance to selected public schools.

Target Population

Students in grades 7-12; Hispanics, black, Asian Americans (they say Native American but do not provide any numbers to back up) - 150 all from public schools. Students must be in top 25% of their class.

Funds

85-86 total budget of $30,000 all corporate funds.

Outcomes

Data not available at present - just this year instituted a tracking program for students.

Evaluation

The GCAME Board of Directors is responsible for periodic program inspection/evaluation.

UNIVERSITY OF KANSAS

STUDENT COUNCIL FOR RECRUITING, MOTIVATING AND EDUCATING MINORITY ENGINEERS (SCoRMEBE)

As a student organization at the University of Kansas School of Engineering, SCoRMEBE encourages minority students to choose engineering careers and provides academic and financial support to minority students enrolled in the School of Engineering. The SCoRMEBE program was born in 1970 through the combined efforts of three Black engineering students and the faculty and administration of the School of Engineering. In 1971, SCoRMEBE initiated the summer program and financially assisted fourteen students. The first permanent director (appointed in 1973) established the Symposium on the Participation of Minorities and Women in Engineering, an event which has become an annual feature of the program. SCoRMEBE established its own endowment fund with the help of a number of area businesses and the KU Endowment Association.

An organization for students which is also the responsibility of students, SCoRMEBE meets the needs of minority students while involving them in planning and organization, cooperation and leadership. The direct involvement of students in recruitment, fundraising, and other aspects of the program allows them to gain confidence in themselves and pride in SCoRMEBE. Participation in the supportive services available to all students in SCoRMEBE is of equal or greater importance to students than financial aid. Examples of formalized support programs include tutoring, group study sessions, and the pairing of underclass students with upper class members in the same engineering discipline in order to foster a "big brother" or "big sister" relationship. The director and student resident advisers are also available for counseling and help with any type of difficulty that arises. SCoRMEBE participants are involved in regular meetings and frequent social and educational events. SCoRMEBE provides placement assistance as well.

Target Population

Entering freshmen through graduate level; blacks, Chicanos, Native Americans; total 88, (90) from public school. Take some students from other states.

Outcomes

Have college matriculation and graduation data only to the extent of where students have been hired.

Evaluation

School of Engineering and Supportive Educational Services handle evaluation process.

THE KINKAID SCHOOL - HOUSTON INDEPENDENT SCHOOL DISTRICT

MATH SCIENCE INSTITUTE

In 1976 the Kinkaid School and the Houston Independent School District established on the Kinkaid campus a summer Math/Science Institute for able public school students drawn primarily from the minority community. It is designed to help students obtain, through three levels of instruction on campus and a fourth level in an off-campus work/pay experience, the strengthening in math and science which will prepare them for College Board examinations, for upper level courses and ultimately for engineering related careers.

Classes are small and instruction is of the highest calibre so that interested students benefit significantly. In addition to the daily classes in mathematics, computers, electronics, drafting, chemistry and physics, there are many other enriching experiences - Math and Verbal SAT Prep, contact with successful engineers and scientists, trips to engineering sites, opportunities to use modern technology and projects involving data gathering and analysis. The faculty is chosen from among the ablest teachers at Kinkaid and HISD. Classes are conducted for 6 weeks, seven hours per day. Kinkaid provides the educational facilities. HISD provides most of the students and some of the science equipment as well as transportation for students.

Target Population

Students at the 9th, 10th, 11th and 12th grade levels; Hispanics, blacks and Asian Americans (90) from the public school system.

Funds

The corporate community (EXXON, SOHIO, Shell, TEXACO, etc.) provide most of the $44,000 budget. Gifts in kind amount to approx. $21,450.

Outcomes

They try to keep college matriculation records. Between 90% to 100% enroll in college; about 80% in engineering, science, math fields. Some of the colleges attending: MIT, Rice, University of Houston, Texas A&M, etc.

Evaluation

The Institute does not have a regular evaluation process.

LOUISIANA STATE UNIVERSITY

RECRUITMENT INTO ENGINEERING OF HIGH ABILITY MINORITY STUDENTS (REHAMS 1 and 2)

Recruitment into Engineering of High Ability Minority Students at Louisiana State University operates in two parts, REHAMS 1 for high school students and REHAMS 2 for undergraduates.

The purpose of REHAMS 1 is to offer to the academically talented minority student an opportunity to develop a realistic concept of the types of activities and thought patterns which characterize engineering; and to be made aware of various fields of engineering. The focus of the four-week program is educational enrichment. This will be accomplished through coursework in mathematics, computer usage and oral and written communication skills. These subjects will be supplemented by the development of analytical and conceptual modes of thinking, presentation of methodologies for solving engineering problems, and the introduction of computational methods in engineering. The participants will be given an introduction to the different fields of engineering by individual faculty from various specialities. Counselors (advanced engineering students) offer guidance in understanding college life, in consideration of engineering as a career, in how to be successful in the courses and in using the final year in high school to prepare better for college and a career in engineering.

The purpose of REHAMS 2 is to offer to the academically talented minority student an opportunity to enroll in the College of Engineering at Louisiana State University during the 1986 summer term (early enrollment). This program is designed to start participants in the engineering curriculum of their choice during a period when there will be an optimum opportunity to become acclimated to University environment and life and be successful in the engineering curriculum. Participants will be enrolled for college credit in selected basic courses in the engineering curriculum which include mathematics, English, graphics and computer programming. Each student will be enrolled for approximately 8 credit hours. Special counseling during the registration period will help identify any deficiencies and initiate appropriate corrective actions. Special tutors will be provided and all participants are obligated to attend tutorial sessions.

Target Population

High achieving minority students - REHAMS 1 post 11th grade, REHAMS 2 undergraduate and graduate - blacks, Native Americans, Mexican Americans, Puerto Rican Americans (total 382, numbers not divided by sex or ethnicity). Participants must have outstanding high school grades, high achievement on standardized tests, recommendations from high school teachers, and for REHAMS 2 must be admitted to LSU in an engineering curriculum.

Funds

Total budget 85-86 $145,000 - $120,000 in external funds, approx. $25,000 institutional.

Outcomes

Have no records except those who enroll in LSU. After entering the college the graduation rate is approximately the same as majority students.

Evaluation

By students and administrators.

MATHEMATICS, ENGINEERING AND SCIENCE ACHIEVEMENT (MESA STATEWIDE CALIFORNIA)

The MESA organization's mission is to increase the number of students from ethnic groups historically underrepresented in math and science professions who complete a four-year university degree in a math-based field. From its inception in 1970 at Oakland Technical High School, the program has provided effective academic counseling and support services for students from MESA's target populations - black, Mexican American, American Indian and Puerto Rican. In 1977 the MESA program expanded throughout the state of California. With the inception of the University level Minority Engineering Program in 1982 and the Junior High Program in 1984, continuity of support for students has been established from seventh grade through graduation from university.

Operating in junior high schools that feed MESA high schools, MESA can now identify seventh and eighth grade students with math aptitude and interest and redirect their school work where necessary to college preparatory classes. Specifically aiming to prepare junior high students to take Algebra I so that they qualify for MESA's high schoool program. Directors of the MESA Pre-college (high school) Program work with industry, educators, community groups, college campuses and parents to conduct challenging, skill-building activities for high school students. In addition to many special activities for pre-college students, such basic enrichment opportunities as student leadership retreats, MESA Day competitions and special college and career days on college campuses are offered. Regular activities and services: organized study, summer enrichment programs, academic advising, scholarship incentive awards, career exploration, family involvement and MESA meetings where students meet to organize MESA activities at their schools.

In cooperation with university faculty and staff and industry supporters, MESA operates a Minority Engineering Program (MEP) which implements highly effective methods to retain students in these demanding academic programs and to prepare them for transition from the academic to the professional world. In addition to the MEP graduates who entered the professional work force, many undergraduates work during the summer in degree-related positions with MESA's business and industry supporters. Regular services and activities: recruitment and admission

activities, freshman year orientation and guidance, counseling services, the MEP study center, support of minority student engineering organizations, career development and summer jobs, financial aid and scholarships, summer bridge program.

Target Population

Students grades 7-12 and college; American Indian, black, Mexican American, Puerto Rican; mostly from public school (no numbers provided).

Funds

20 college campuses house MESA field operations; the state of California with $5 million funds approx. 50% of MESA's budget; local school districts also contribute. Local industry support.

Outcomes

Data beginning with the 1981 high school class: 90% college matriculation, 67% in engineering/science/math. College graduation rate to be established in the fall 1986.

MICHIGAN STATE UNIVERSITY

ENGINEERING EQUAL OPPORTUNITY PROGRAM (EEOP)

The original effort by the College of Engineering of the Michigan State University to strive for parity representation of traditionally under-represented ethnic minorities began when a small group of concerned faculty members created the Engineering Equal Opportunity Program committee and began the job of recruiting, advising and providing financial assistance to minority students interested in engineering. In 1974 an educational research program entitled An Experimental Engineering Student Development Program for Ethnic Minority Students was designed to address the problems of ethnic minority students who had not mastered the necessary prerequisite skills to enter traditional engineering programs. The major components of that project were a flexible self-paced mastery model curriculum in science and mathematics, peer association and counseling, and academic advisement. In the spring of 1976 the position of Director of Minority Affairs was created and the Office of Minority Student Education was established.

EEOP's various programs address the issues of inadequate educational preparation in mathematics and science, the socio-cultural transition to college life and academic advising and counseling.

O Student Assistant Program - a mentor system providing support for freshman/transfer students in transition.
O Orientation Class - for freshman/transfer engineering students. The course aims at broadening student perspectives of the

variety of engineering disciplines by exposure to company representatives, selected readings and university resource people.
O Early Warning System - a mechanism through which students and academic advisors are alerted to a student's poor academic performance early in the quarter so that an effective strategy for recovery may be planned.
O Guided Learning Center - a tutorial facility which also provides a computer-assisted self-help lab and various workshops on topics such as mathematical word problems, study skills and exam reviews.
O DAPCEP - a summer education program for pre-collegiate students.

The EEOP supports four academically oriented programs designed to assist approximately 80% of incoming freshmen students who require, by the College of Engineering standards, remedial assistance in mathematics: formal courses in pre-calculus mathematics and tutorial services for all other technical courses related to the engineering discipline.

Target Population

Students grades 11 & 12, undergraduates and graduates; blacks, Hispanics, Native Americans (total 397 - no breakdown for gender nor ethnicity). Most from public school.

Outcomes

College matriculation rate - approx. 75%, 75% in engineering science/math. Incomplete data on graduation but 65% once having entered the College of Engineering.

Evaluation

Evaluation reports based on student surveys, staff input and program coordinators. Each individual program is evaluated in this manner at various times during the year including the end of the academic year.

THE MIDWEST PROGRAM FOR MINORITIES IN ENGINEERING (CIC+MPME)

The Committee on Institutional Cooperation is the academic consortium of the Big Ten Universities plus the University of Chicago. The Midwest Program for Minorities in Engineering (CIC+MPME) was initiated in 1974 with funding from the Sloan Foundation. In addition to the engineering schools of the CIC institutions and their branch campuses, participants included engineering schools at seven other midwestern universities (University of Detroit, Illinois Institute of Technology, Indiana University, Purdue University at Indianapolis, University of Notre Dame, Oakland University, Wayne State University).

The purpose of the program was to increase the pool of minority

high school graduates qualified to undertake training for the engineering professions. In addition the programs on each of the campuses have been concerned with recruitment and retention of minority engineering undergraduates. Sloan Foundation support was gradually phased out, ending in 1981. Since the inception of the program there has been a significant increase in minority engineering enrollments at the participating institutions (from a total of 1319 in 1974-75 to 3411 in 1984-85). In addition, programs which had their inception with MPME are now well-institutionalized at several of the participating universities. Since 1980-81, however, enrollments have remained relatively stable and are still low relative to the proportion of minorities in the total population. In the past year, there have been discussions involving the CIC office and MPME project directors of a renewed effort focussed on precollege programs, possibly as early as the elementary level.

In addition to the MPME, the CIC operates three minority graduate fellowship programs, one of which is for students in science, mathematics and engineering. There is no overlap between the programs.

The CIC+MPME is a highly decentralized program involving 16 different campuses.

Target Population

Students grades 9-12 and undergraduates.

NORTH CAROLINA COUNCIL FOR MINORITIES IN SCIENCE, MATHEMATICS AND ENGINEERING (NC COUNCIL)

The North Carolina Council for Minorities in Science, Mathematics and Engineering is a not-for-profit organization consisting of three locally based education improvement programs. Each local program is focused on increasing the number of secondary minority students in mathematics and science courses - and on improving the achievement of those students in said courses.

The NC Council proposes to embark on a three year program aimed at broadening and expanding such locally-based programs. The council plans to broaden the impact and effectiveness of the existing Locally-Based Education Improvement Programs in North Carolina (ROCAME, RVCAE, RECAST) by

* designing and beginning to implement a Mathematics Skills Improvement Program for minority students participating in these programs;
* designing, implementing and supporting an increased number of academically focused competition events for minority students.

The council also plans to create additional Locally-Based Education Improvement Programs in other geographic areas of NC and to improve the gathering of data regarding minority participation in upper level math/science courses in those

geographic areas served by the NC Council.

There exist within North Carolina three fully implemented Locally-Based Education Improvement Programs configured to include various constituents of the community - including business, industry, professional societies, government and education (i.e. college, university and local school systems). These local improvement programs are addressing the problems of underrepresentation of minorities in secondary level math/science courses - and have joined in a statewide NC Council in order "to increase the number of minorities preparing for and entering technical, scientific and engineering fields." Active local chapters are: Region East Carolina Affirmative Science Training (RECAST), Roanoke Valley Council for the Advancement of Engineering (RVCAE) and Region 'O' Council for the Advancement of Minorities in Engineering (ROCAME). (All target minority students.) Other active members include: North Carolina State University, NC Board of Science and Technology and NC Department of Community Colleges.

The NC Council has targeted the ROCAME locally-based program to pilot the development and implementation of these new tutoring/retention programs by:
* providing well-qualified peer tutors via a high-quality training program,
* establishing local ownership of the tutoring programs,
* providing ongoing quality control on the tutoring programs.

Proposed 86-87 budget: $39,870 from funds proposed from NACME; $41,600 funds raised/provided by NC Council; $55,000 matching funds (in-kinds).

Evaluation model will consist of a two-step process/product evaluation plan. Program goals will be restated in the form of behavioral objectives.

NORTH CAROLINA STATE UNIVERSITY SCHOOL OF ENGINEERING

PROGRAM AND EVENTS FOR RECRUITMENT AND RETENTION OF MINORITIES

Pre-college Programs:

Junior Engineering Technology Society (JETS)- NCSU Director of Engineering Special Programs is the state coordinator for the National JETS organization. Program conducted for high schools that provide both substance and motivation for potential engineering students.

Computer Related Engineering and Science Studies (CRESS)

PROGRAMS FOR RECRUITMENT AND RETENTION OF MINORITIES AND WOMEN:

Student Introduction to Engineering (SITE)

On-Campus Engineering Workshops-During 1984-85, 1240 North Carolina high school students participated in seventeen workshops. These one-day workshops give the students an opportunity to gain a close-up view of some of the many engineering activities carried on at NCSU.

R.J. Reynolds Tutelage Progam and Summer Transition Program

LOCAL CONSORTIUM PROGRAMS:

The NCSU School of Engineering provides staff consulting and technical services as well as organizational and planning assistance to the following local consortiums/organizations:

Region 'O' Council for the Advancement of Minorities in Engineering (ROCAME); Region East Carolina Affirmative Science Training (RECAST); Roanoke Valley Council for the Advancement of Engineering (RVCAE).

Southeastern Consortium for Minorities in Engineering (SECME) - Involved in this program are twelve school systems, an average of 2.5 teachers in each of 36 schools, and 5,400 student members of which 41% are minorities. The SECME program operated by the North Carolina School of Engineering is the second largest in the southeastern United States.

North Carolina Council for Minorities in Science, Mathematics and Engineering (NC Council)

Minority student services for NCSU Engineering students:

In the fall of 1982, the position of Director of Minority Student Services was created specifically to address the needs of minority students already enrolled in the School of Engineering. An educator/counselor was hired to fill this position with a mandate to: 1) meet the individual and specific needs of all minority students, especially those who may appear to be marginal; 2) establish an academic monitoring and early warning system; 3) better facilitate student, faculty and administration interaction; 4) heighten and enrich the level of academic performance; and 5) integrate experimental learning with theoretical learning. The goals and objectives of the Director of Minority Student Services are to recruit the very best students possible, increase their level of retention, and graduate these students to help supply the demands of the corporate world as well as the educational arena. The specific functions of this position are:

O counseling
O recruiting/admission
O securing summer internships for students
O providing a summer transitional program during the second session each year for entering freshmen in engineering.

U.S. ARMY - COMPUTER RELATED ENGINEERING AND SCIENCE STUDIES (USA-CRESS)

USA-CRESS is a four-week computer hardware oriented program for advanced high school students with an interest in pursuing careers in engineering and science. The program aims to develop students' awareness of the sophistication of computers and the techniques of interfacing computers with real world devices. The program also hopes to direct students toward doctoral research programs in the areas of Robotics and Industrial Automation.

Approximately 60 gifted and talented students (40% minority) attend a four week program in computers and robotics which includes: room and meals, classroom instruction, career counseling and supplies/equipment. During the program, participants will gain a close-up view of the expanding and exciting fields of computers, microprocessors, and robotics. The emphasis is on utilizing computers/microprocessors to interface with (and control) real world devices such as motors, lights and a variety of sensors. This will assist the students to comprehend and apply their present mathematical and scientific knowledge to industrial automation and robotics. USA-CRESS features the following:

O structured programming in Pascal
O electrical waveforms and measurements
O boolean logic and numbers systems
O digital logic circuits
O microprocessor organization and programming
O special lectures and tours.

The program is anchored by a concentrated curriculum of lectures, laboratory experiments and group and personal projects where the student will work at their own best speed. The students will gain hands-on experience with the latest advances in industrial automation and robotics technology while working in a college environment.

Target Population

Talented high school students with 95 cut scores; 40% black; over 90% public school; approx. 60. Tuition/registration fee of $700. Teacher or counselor must recommend.

Funding

Total budget: $55-60,000; Office of the Army 45%, Committee on Education 15%, Student Fees 25%, Allocations from State Funds 15%.

Outcomes

No data available

Evaluation

Evaluation informal: blend between theory and practice; some problem getting students to work together (discipline, all prima donnas).

STUDENT INTRODUCTION TO ENGINEERING (SITE)

SITE is a summer program for promising high school sophomores, juniors and seniors with an interest in and the potential for pursuing careers in engineering and science. The program aims to introduce students to a conceptual understanding of the fields of engineering as they would be experienced by a student of engineering; and to develop a positive attitude toward NCSU. Approximately 350 students attend four one-week programs which include: room and meals; classroom instruction; engineering mini-labs; career counseling and supplies/equipment. Since 1983 this program has been operated as a 50/50 minority/nonminority program. Before that time, it was operated as a MITE program with a separate program for women. For more than ten years these NCSU School of Engineering summer career exploration programs have been among the five largest in the nation.

In the SITE program students are involved in demonstration classes, laboratory projects, interaction with engineering students and professors, and informal living/learning experiences. Emphasis is on a working week and an academic experience. The professional career opportunities available to engineering graduates are emphasized along with the nature of various engineering fields. During each week-long workshop, SITE participants gain a close-up view of engineering activities at the forefront of technology and of various engineering fields. Students are exposed to lectures and laboratories in four of the five engineering disciplines. They see first hand what it is like to be an engineering student, go on tours of different schools, attend current summer classes and are given financial, developmental and academic information about NCSU.

SITE features the following:
O demonstration classes and intensive laboratory sessions in Mechanical, Aerospace, Electrical, Civil, Industrial, Materials, Biological and Agricultural, Chemical and Computer Engineering
O hands-on experience in the latest technological endeavors
O extensive interaction with engineering students and faculty
O noted engineers make presentations giving an insight into the professional practice of engineering. Unique features include: Buddy Day (participants spend half day with NCSU students), blend of half day labs and half day general orientation.

Target Population

Promising high school sophomores, junior, seniors; all from public school; 1985 total: 256 (96 female, 134 black). Requirements: enrolled in advanced math and science courses, grade point average, PSAT/SAT scores, recommendation from teacher/counselor; school should nominate. Tuition/registration fee $200.

Funding

85-86 total budget: $48,000 (self-supporting: 65% student fees, 20% state funds).

Outcomes

No formal outcomes data: about 25% come to NCSU Engineering, 25% NCSU non-Engineering; 90% of those who don't come to NCSU do go to 4 year college.

Evaluation

No data

J.P. REYNOLDS INDUSTRIES TUTELAGE PROGRAM
ACADEMIC SUPPORT AND ACHIEVEMENT PROGRAM

The ASAP program is designed to provide tutorial support for both freshmen and sophomores who are enrolled in engineering during the regular academic year. Approximately 300 students request tutoring per semester, with approximately 30% being minority. Approximately 20 tutors are hired per semester to provide the tutoring service. Students who take advantage of this program tend to show approximately 0.4 higher quality point average than similar students who do not participate. This in turn has increased retention for freshmen and sophomores to 85-90%.

During each semester the ASAP program offers tutorial assistance in twelve basic courses. Tutorial sessions are of three types: problem solving sessions (tutor emphasizes methods of setting up problems and solving them rapidly; major emphasis of the program); group sessions (tutor reviews homework, class notes and tests; tries to assist in conceptual areas and developing good study skills); and individual sessions (for English only; tutees who are referred from other sessions). Tutoring sessions take place in classrooms once a week for two hours. Attendance is not mandatory. There usually is a waiting list.

Special features that seem to work for the program are:
O Engineering students, who have been through the same experiences, tutoring other engineering students
O Tutors very capable and evaluated regularly
O Strong support from faculty and staff
O Strong support from national honors fraternity
O Develop skills for general studies not just particular courses

Target Population

College freshmen and sophomores; mostly blacks, includes whites and Asian Americans; majority public school; 85-86 total: 438.

Funding

Total budget approximately $24,000 (total from J.P. Reynolds $38,500, rest for summer transition program).

Outcomes

Longitudinal study (10 years) to be completed in summer 1986, no outcomes data until then.

Evaluation

Evaluation reports from students, tutors and faculty members (not provided).

SUMMER TRANSITIONAL PROGRAM (STP)

In the summer of 1981, R.J. Reynolds Industries, Inc., assumed sponsorship of both the Summer Transition Program, which assists incoming freshmen during the second summer session, and the Academic Support for Achievement Program. Tutorial support for the STP is available for English 110, 111 and Math 100, 115,111, and 102.

In the past, the STP program made special efforts to encourage attendance of entering engineering freshmen who projected a certain weakness in their mathematics and/or English background. However, in 1985 the STP program expanded its focus to include students who were Junior College or Community College transfers and academically gifted students who could earn positive and rewarding benefits from this program academically and socially. This approach helped to eliminate any stigma that might be perceived by participants and take into consideration that fruitful student transition, in all cases, is skewed heavily toward the socialization and adjustment process.

In addition to the courses taken by students in the STP program, weekly meetings were also conducted. These weekly sessions consisted of a basic structure with some time in each session for miscellaneous concerns. Some of the structured topics discussed in sessions during the STP program were as follows:
O How to succeed in Engineering School
O Students on interracial campuses
O Refining your study skills and time management
O Self-concept and academic achievement
O Open-ended concerns and discussions.

Target Population

NCSU students, primarily minority; mostly from public school; 85-86 total: 35+

Funding

85-86 budget approx. $1,012,000 (total $38,500 from R.J. Reynolds). Some scholarship aid provided for students.

Outcomes

No data

Evaluation

No data

NORTHEASTERN UNIVERSITY

PROGRESS IN MINORITY ENGINEERING (NUPRIME)

Northeastern University's NUPRIME program was developed in 1974 as part of a nationwide effort to increase the number of qualified black, Hispanic, and Native American engineers in all fields of engineering. Among its purposes are to provide personal attention (workshops and tutorials) to engineering students particularly during freshman year, and to make sure that minority students in the College of Engineering have sufficient financial resources to continue their studies until graduation. NUPRIME also works on an ongoing basis with Boston-area school and community organizations to increase awareness of opportunities within the engineering field. NUPRIME staff members recruit qualified or qualifiable minority students for Northeastern's engineering programs and, more important, offer the necessary support services to help them succeed and graduate as professional engineers.

Initiated in 1982, NUPRIME's Directed Recruiting Program is designed to address the special concerns and questions of minority students interested in the engineering profession so as to substantially increase minority enrollment. NUPRIME provides workshops and tutorials, financial assistance and community consulting. NUPRIME is eploring and developing new programs: NUPRIME Bridge (prefreshmen), NUPRIME Early Entry (pre-high school - third grade), NUPRIME The Exceptional Student (offers promising minority high school students challenge and enrichment in the area of engineering; possible early college admission).

Target Population

Undergraduate students; black, Hispanic, Native American; (no numbers provided).

Funding

No information

Outcomes

101 enrollees from 200 acceptances all in engineering, engineering tech. or computer science. College graduation rate: 55% all in engineering. Attend Northeastern.

Evaluation

Indicates material attached but not satisfactory.

NORTHEASTERN UNIVERSITY PROGRESS IN MINORITY ENGINEERING - HS (NUPRIME)

Northeastern's NUPRIME, a high school program, is designed to increase interest in engineering among minority high school students and to help them better prepare for college level study. The program began in 1978. Specific objectives include:

O increase number of qualified minority secondary school students pursuing careers in the engineering professions
O increase the number of minority students enrolled in the various programs offered by Northeastern's College of Engineering
O identify minority students interested in engineering and other technical fields
O help to improve and enrich mathematical and other academic skills of participating students
O provide students with opportunity to become familiar with the work of engineers in a variety of engineering disciplines
O provide admissions and financial aid advice for entry to NU
O supplement tuition with SIPPICAN scholarships.

Activities include: two hour classes one night a week focus on math/physics; special career, admission and financial aid counseling; field trips (recreational, cultural and career); awards (NU Jackets, scholarships, etc.).

Target Population

Freshman through senior in high school; minority. Requirements: passing math grades, desire to learn, 80% attendance, written recommendations from math, science teacher or guidance counselor where necessary. (no numbers or breakdown provided)

Funds

SIPPICAN Ocean Systems Inc. is funder. No numbers provided.

Outcomes

90% college matriculation rate. No other data provided.

CAREER AWARENESS PROGRAM

The National Technical Association's Career Awareness Program is designed to increase high school students awareness of careers in scientific and technical areas and to provide role models for them.

Components include early identification of target students, recruiting, pre-college prep, freshman orientation, academic, career, financial, personal and peer counseling; and linkage to local industry. The program began in 1974.

Target Population

Students grades 9-12; black; public school (total 40). Students have to show strong science and math skills.

Funds

Not specified. Sources: NASA, Standard Oil Company

Outcomes

No data

Evaluation

No data

PITTSBURGH REGIONAL ENGINEERING PROGRAM (PREP)

The Pittsburgh Regional Engineering Program is an industry-supported program designed to encourage minority youngsters and others to become engineers and scientists. PREP is the Pittsburgh chapter of NACME. PREP's major objectives are to identify minority youngsters capable of pursuing engineering/science careers and to motivate these youngsters to take the high school courses required for admission to engineering colleges.

Among PREP's activities:
O provide role models in engineering for minority students
O develop and provide engineering career information for potential engineering students
O coordinate Pittsburgh area activities for minorities
O serve as a center for scholarship information
O introduce parents and community groups to engineering opportunities
O encourage colleges and school districts to develop engineering-oriented curricula
O coordinate activities for pre-engineering students at secondary school levels
O develop exhibits and educational materials
O encourage other Pittsburgh area corporations to support the program as it benefits business in general wherever engineering plays a vital role.

PREP is an action program. It is unique because it is designed to create career awareness among students in the early grades, and offers continuing engineering/science-related experiences during the remaining school years. PREP is trying to establish a tutorial program. PREP3 Club activities have been replaced by counseling/mentoring services. Emphasis is placed on the middle school phases of the program (PREP1 & PREP2).

Target Population

Students grades 6-12 (PREP1 - 6th; PREP2 - 7&8th; PREP3 - 9-12th; PREP4 - 9&10th); mostly black (some "other" - white?); Teacher/counselor recommendations. Total 729 all public school.

Funds

Total budget 85-86 $78,400 - new grant from ALCOA Foundation ($18,000). Support from local corporations and universities.

Outcomes

Tracking system has only recently been initiated. 392 of 1200 minority graduates surveyed; 180 responses to survey. 115 in math/science/engineering programs, 156 in some college program.

Evaluation

Program is evaluated by the Board of Directors.

PROJECT INTERFACE

Project Interface developed through the collaborative work of a large urban church, Allen Temple Baptist Church, and a black professional society, Northern California Council of Black Professional Engineers. The philosophy of the project is based on a belief in the potential of young people and a commitment to providing the human and material resources needed to develop that potential. The goals are as follows:

O to increase the number of minority students in science and math related fields.

O to produce better prepared, more confident minority math and science students.

O to expose minority junior high, high school, and community college students to mathematics, science and engineering, to the practicality of these disciplines and to the many possibilities that the study of these disciplines affords.

We work with students who are not presently enrolled in college prep classes; in Oakland, these are Level II students. Level I students are college prep. Our pool is Level II's with promise and Level I's in jeopardy. We seek to boost students from Level II to Level I classes. We bagan with Federal money and now operate on private funds. We network with schools and post secondary institutions but are community based. We have three years of test results to demonstrate that "average" youngsters can achieve if expected to do so.

Basic activities of Project Interface are small, rigorous tutorial groups taught by junior college students pursuing careers in mathematics, sciences of engineering; field trips, academic and personal counseling; a Role Model/Mentor program; and a Saturday computer program with the College of Alameda.

Target Population

Students from grades 7-12 and undergraduates. Mostly black, account for one Chicano and one white; total 78 mostly public school (Oakland area).

Funds

Total budget 85-86 $133,000 - foundations, corporations, individual donors, fundraising. Charge $13 for study skills seminar and $50 for computer class.

Outcomes

1984-85 8 of 13 students enrolled at the junior college level transferred to four-year schools all in engineering/science/math. In the California State University and California State system.

Evaluation

7-12 students' scores on the Comprehensive Test of Basic Skills are collected annually.

PURDUE UNIVERSITY SCHOOL OF ENGINEERING

MINORITY ENGINEERING ADVANCEMENT PROGRAM (MEAP)

The objectives of the Purdue University School of Engineering and Technology at Indianapolis MEAP Program are:

O to identify, recruit and select a cadre of minority students who demonstrate the potential for success in engineering from grades 6 through 9,

O to retain a number of qualified and qualifiable students throughout their high school years, to assist them in gaining entrance to college, obtaining financial aid and securing valuable summer work experiences,

O to increase the students' awareness of career options for engineers and technologists,

O to provide student access to and interaction with successful role models from education and industry who serve the program in the capacity of instructors, counselors and mentors,

O to provide by means of the summer workshop "hands-on" laboratory experiences and academic instruction similar to those they will encounter in their first year of engineering study,

O to demonstrate the realities of the workplace by providing tours and other field experiences in cooperation with local industry,

O to make available to the students, their parents and counselors information regarding college entrance requirements, admission procedures and financial aid,

O to provide summer engineering-related work experiences in local industry for MEAP graduates who have been accepted into

engineering programs (pre co-op experience).

Since its beginning in 1974, MEAP has served over 700 Indianapolis area minority students: identifying, recruiting, motivating and helping to prepare them to enter engineering and technology programs in college. Components include: skill-building summer workshops (including motivational sessions and career orientation), academic year activities (workshops planned monthly for Saturdays during the year include "How to Apply for Financial Aid" and "How to Write a Resume"), pre-college co-op program (eligible graduating high school seniors who plan to study engineering are given the opportunity to apply for engineering related jobs in local industry), college component (once the student enters the School of Engineering and Technology at Indianapolis, he or she can receive counseling, tutoring and financial assistance designated for minority students in particular).

Target Population

Students grades 6-12, undergraduates (perhaps graduates in the future); blacks, Hispanics, Asian Americans,(Native Americans indicated); socioeconomic factors not criteria but considered in recruiting; 90% public school, total 85-86: 133.

Funds

Total 84-85 budget: $75,900 ($32,400 external, $43,500 institutional, local industry and individual contributors.

Outcomes

About 90+% of students matriculate in college, 65-75% in engineering/science/math. Retention study not yet conducted, though planned so no graduation rates. Most attend Purdue University at West Lafayette; others at Notre Dame, Indiana State, Rose Hulman, few attend out-of-state schools.

Evaluation

Students asked to evaluate summer workshop; survey conducted of program alumni each year.

RENSSELAER POLYTECHNIC INSTITUTE

OFFICE OF MINORITY STUDENT AFFAIRS (OMSA)

All the undergraduate programs for minority students at RPI fall under the umbrella of the Office of Minority Student Affairs. This arrangement maximizes the chances for OMSA staff to assist minority and disadvantaged students in their academic, professional, community and social development. Improvement in the quality of minority support services have resulted in significant increases in the recruitment and retention of

minority students. OMSA continues to work with the RPI Admissions Office to attract talented minority candidates. The recruitment approach includes the following: diversified high school visits, professional staff, extensive direct mailing, the development of special literature and on-campus weekend exposure to prospective students. Furthermore, the Institute extends comprehensive and high quality financial aid award packages to students from disadvantaged backgrounds.

The primary goals of the OMSA are to provide access and the necessary support service to increase our students' chances for academic success. To maintain corporate/industry relations that will result in summer, permanent and co-op opportunities for our students. We have been successful in implementing a broad range of programs and services thereby resulting in better than national graduation rates. We have also developed and institutionalized our fundraising efforts so as to keep abreast of available external resources. A unique quality about our program may be our synergistic approach, with both internal and external (corporate) participation, towards the development and implementation of successful retention strategies for our students.

Under the OMSA umbrella a comprehensive set of pre-college and pre-freshman minority student programs are provided: Bridge, HEOP, CCP, Preface.

Target Population

Undergraduates and graduates to a limited degree; black, Hispanic, and Asian American (the first year), Native Americans also considered; total 85-86: 47. Public school (135), private (27), parochial (40) from all years.

Funds

Total varies, institutional 85-86 $100,000 average annual exclusive of financial aid; $550,000 average annual contribution from government, industry and foundations.

Outcomes

We enroll approximately 70% of students we offer admission to, approx. 90% in engineering/science/math. Approximately 61% graduate from college.

Evaluation

Each year we review pre-freshmen program efforts and each semester we conduct an academic review of all program students. Fall 1985 Academic Student Summaries Report is attached.

BRIDGE SUMMER PROGRAM

Bridge is an eight week residential pre-freshman Summer Program designed to enhance the chances for academic success of regularly admitted minority students at Rensselaer Polytechnic Institute. Moreover, the program helps to increase retention and enhance the college experience for this targeted population by exposing them to college life at RPI during the summer months. The program provides accepted participants full scholarship support.

Students are given the opportunity to enroll in two academic credit bearing courses; thereby reducing the typical course load demands of the freshman fall semester. Another important objective of the Bridge program is to introduce the students to the comprehensiveness of the RPI campus environment. This was accomplished by offering the participants the opportunity to familiarize themselves with the physical, social and cultural atmosphere of the campus. Students are exposed to RPI faculty and academic expectations. The uniqueness of Bridge is its impact on fall academic course load and industry involvement.

Target Population

Pre-freshmen, black, Hispanic. All minority students accepted to RPI are invited to attend. 85-86 total 35; public school (68), private (5), parochial (25) from all years.

Funds

Total 85-86 budget $95,000 (external $70,000) - new sources from Atlantic Richfield and Amoco Foundation. Students are responsible for supplying their own books and transportation.

Outcomes

100% college matriculation rate; 95% in engineering/science/math; college graduation rate: 55+ % in eng/sci/math.

Evaluation

Review of student performance and academic summaries - data included in final report and academic summaries attached.

HIGHER EDUCATION OPPORTUNITY PROGRAM (HEOP)

HEOP's goal is to assess students potential for RPI academic expectations, to prepare them for successful course performance and assist them to meet RPI's expectations. The HEOP-Program at RPI aims to provide access to New York State's minority and historically disadvantaged students who would otherwise not have the opportunity to enroll in such a selective university. Above and beyond the objectives of access we are committed to provide the supportive services that will help ensure our students' chances for academic success. In this regard, we are committed to maintaining a program enrollment that will allow us to maximize institutional and state provided resources to the benefit of the students we enroll. Components include: pre-

college prep, first-year orientation, counseling, tutoring, remedial instruction, summer instruction, direct financial aid and some staff development for high school counselors and college faculty.

The HEOP Program serves students who are by definition inadmissable to RPI. By comparative standards, they are high risk students in a competitive environment like RPI. However, through close academic monitoring and the availability of support services they graduate at rates well above the national norm.

Target Population

Pre-freshmen, undergraduates; black, Hispanic, Asian American, Native American (in 83-84). Students must be NYS residents they must also meet economic guidelines as stated by the NYS Department of Education. Total 85-86: 26; public school (89), private (4), parochial (12) from all years.

Funds

Total budget varies; 85-86 institutional funding was an annual average of $90,000; external $210,000. Sources: RPI and NYS Department of Education.

Outcomes

Approximately 85% of those offered admission enroll; 90% in engineering/science/math. Average of over 47% over the past 5 years have graduated from college all in engin/sci/math.

Evaluation

Program efforts are reviewed each summer. Academic summaries are conducted each semester.

CAREER PHYSICIANS PROGRAM

The purpose of the Career Physicians Program is to prepare minority students and students with educationally disadvantaged backgrounds for careers in medicine and biomedical science. This program is co-sponsored by Albany Medical College and the Clark Foundation.

Some special features of the program are as follows:

O Accepted students begin their studies at RPI the summer immediately after graduation from high school. They register for two credit bearing courses, Chemistry I and Chemistry II; students also attend weekly seminars at Albany Medical College.
O After the second year of study, the student goes to AMC for an eight week residency. There they attend classes and are assigned to a doctor to do routine tasks in the hospital.
O At the end of residency the students file an admissions application. Acceptance to AMC will be effective two years hence

provided the student maintains satisfactory levels of academic and personal performance.

This program is unique because it allows students from disadvantaged backgrounds to prepare themselves for a medical career at their own pace. The fact that they are given early acceptance to AMC motivates them to work harder.

Target Population

Entering freshment; blacks, Hispanics, Asian Americans (83-84). Total 85-86: 5; public school (9), private (2) for all years.

Funds

Total budget varies, 85-86 external funds were $50,000; institutional funding varies. Funds from RPI and Clark Foundation.

Outcomes

College matriculation rate 100% all in engineering/science/math. No graduation data, first class graduates in May 1986.

Evaluation

General review of academic rate of progress.

PREFACE PROGRAM

Preface is a typical program along the lines of MITE and other pre-engineering programs. The goals of Preface are to expose students to engineering as a possible career choice.

Preface is a non-credit bearing, RPI- and government-funded program for educationally and economically disadvantaged high school students. The summer programs provide not only academic enrichment but also positive experience in RPI's environment with RPI's faculty, staff and students. Small classes allow for contact with faculty and staff and individualized attention. The pace allows for interaction between the pre-college summer program participants and the upperclassmen attending regular summer session classes.

Preface has introduced 143 high school students to engineering as an academic discipline and a career. The caliber and motivation of the students selected for PREFACE has been extremely high. Most students are offered full financial funding in order to attend. Participants for the program are recruited nationwide.

Target Population

Students grades 10 & 11; black, Hispanic, Asian American (include Native American). Requirements: review of student statement and high school counselor's recommendations. Total 85-86: 35; public

school (20), private (6), parochial (9).

Funds

Total varies; institutional $15,000, external $15,000 (average annual contributions). Sources: RPI and Office of Naval Research.

Outcomes

Currently developing a follow-up study.

Evaluation

General review of summer efforts.

STEVENS INSTITUTE OF TECHNOLOGY

ACCELERATED MATHEMATICS PROGRAM (AMP)

The Accelerated Math Program is a program aimed at high school seniors or advanced high school juniors. The purpose of AMP is to provide the students with materials not usually thoroughly covered in the high school curriculum, but which are quite important in a college education.

The AMP, a separate component of the Stevens Technical Enrichment Program (STEP), a pre-college program at Stevens Institute of Technology, emphasizes mathematical problem-solving techniques in the physical sciences. All minority programs at Stevens are under the STEP program, a centralized program begun in 1977. This enables resources and staff to be shared. Another plus for the program is that key personnel of the program are also faculty members of the college.

A few years ago, five educators met for a total of 50 hours to design the course. It uses word problems to present and drill the material. The problems are taken from Physics, Chemistry, Economics and Engineering. Applicants are required to take a diagnostic test, and acceptance to the program is based on their performance on the test. The program meets for 2 hours on Saturdays beginning in early October and ending in April. Social gatherings play an integral part in the program.

Five seminars covering various topics are conducted. The topics range from "How to Choose a College" to a video presentation which shows how mathematics is applied to our everyday life. In fall, 1985, AMP developed a second component. AMP I is designed for advanced seniors. There are a total of 32 students.

Target Population

Students in grades 11 and 12; Asian American, Hispanic, black (and other category checked); all from public school. Total 32.

Funds

Total budget 85-86 $7028. The Program receives a special project grant from the New Jersey Department of Higher Education Educational Opportunity Fund Program to increase the number of students in the program.

Outcomes

No data.

Evaluation

No data provided.

UPWARD BOUND PROGRAM

The Stevens Institute of Technology Upward Bound Project has sought over the eighteen years of its existence, to increase the number of disadvantaged students who complete high school, enter college and graduate from an institute of post-secondary education.

The Upward Bound Project has provided intensive academic instruction as well as laboratory and enrichment activities to eligible students. Special emphasis has been placed on: identifying students who are interested in science and engineering; improving their academic performance and skills, especially in the subject areas of mathematics and science; implementing innovative and challenging pre-engineering laboratory and teaching techniques that sustain high interest; and exposing minority high school students to career opportunities in the fields of engineering and science. Project participants receive a comprehensive orientation to the fields of engineering and science in the hopes of broadening their access to these careers.

There is a six week residential summer session which takes place on the campus of Stevens Institute of Technology from the end of June to the beginning of August. A full curriculum of courses and laboratory sessions is offered during this session, with students studying algebra, geometry, trigonometry, physics, chemistry, biology, humanities, engineering, computer science, reading, art, and photography. Daily guidance seminars for all participants are an integral part of the summer curriculum as well, along with comprehensive academic, career, and personal guidance sessions offered on both an individual and group basis. Each Friday throughout the summer is devoted to plant trips.

What makes the program unique?

O That students are involved in classroom enrichment in math and science as well as humanities that follow the courses they are taking in school.

O These enrichment courses continue after the initial six weeks summer for approximately 30 weeks in the academic year on Saturdays one hour each class.
O That we emphasize more math/science courses.
O We teach extended courses not simply mirroring what students get in high school.
O We give homework.
O We demand (not request) progress.

Target Population

10-12 grade students; black, Hispanic, Asian American; total 110; target area high schools. Some income restrictions as stated by Upward Bound guidelines.

Funds

Total budget 85-86 $204,074 (external Upward Bound funding).

Outcomes

College matriculation rate: 98%; 40% in engineering/science/math.

Evaluation

No data.

STEVENS TECHNICAL ENRICHMENT PROGRAM - IN-COLLEGE PROGRAM

In 1968, in one of the first projects of its kind in the nation, Stevens Institute of Technology initiated a program that provides academic reinforcement and cultural enrichment to talented disadvantaged and minority students with interest and aptitude in science and technology. Known as STEP, the program seeks to broaden the access of these individuals to technological institutions and subsequently to increase their numbers within the professional engineering and scientific communities. The STEP In-college program is devoted to the needs of undergraduates. With the support and assistance that the program provides, students who might have difficulty adjusting to the academic environment at Stevens can proceed through the undergraduate years with a reasonable chance of success.

When students enter Stevens through STEP they attend Bridge (see separate description), a pre-freshman summer program. During the freshman and sophomore years, students are required to attend supplementary review and tutoring sessions in most academic subjects. Components include: extra tutorial recitation and review; special faculty advising; personal and academic counseling; cultural activities; limited extra financial aid.

All "minority" and "disadvantaged student" programs are under a single overall director, so that all components can (and do) interact constructively with each other. Components: Pre-college

(80% Upward Bound; 20% private); Advanced Math Program - Saturday math for high school seniors; Bridge- Pre-freshman classes, mostly for students entering Stevens; In-college - as described above.

Target Population

Undergraduate; emphasis on black, Puerto Rican, Mexican American and Native American, but no "cutoffs." Total 101, 85% from public school.

Funds

Total budget 85-86 $132,341 from private corporations and foundations and New Jersey Department of Higher Education Educational Opportunity Fund.

Outcomes

College graduation data: 50%, all in engineering/science/math.

Evaluation

Figures on graduation and progress toward graduation.

BRIDGE

Bridge connects the pre-college and the incollege STEP (Stevens Technical Enrichment Program) programs. Designed specifically for high school graduates about to enter college, participation in Bridge is mandatory for all freshmen entering Stevens through STEP. This six-week residential session includes a series of courses that acclimate students to the academic and social pressure of that all-important freshman year.

Like the pre-college summer program, Bridge features academic coursework, enrichment activities and counseling and tutorial services. During the summer of 1984, Bridge students studied precalculus, calculus, physics, computers, humanities, and chemistry lab. Strategies For Success, a course covering study skills, time management, test-taking tips, reading improvement and communication skills, was also an important part of this preparatory program.

Target Population

Prefreshmen (high school graduates about to enter college); Hispanic, black, Asian American; total 35, almost all public school. All students who are accepted to Stevens via STEP are required to participate in Bridge.

Funds

Total budget 85-86 $61,958 from New Jersey Department of Higher Education Educational Opportunity Fund.

Outcomes

Data on college matriculation. Rate: about 50%, 50% in engineering/science/math. 50% graduation rate, 50% in engineering/science/math.

Evaluation

Summer Program (Bridge) Assessment (attached).

UNIVERSITY OF TENNESSEE, KNOXVILLE

MINORITY ENGINEERING SCHOLARSHIP PROGRAM

The College of Engineering at the University of Tennessee, Knoxville, established a comprehensive scholarship program during 1973 which aims at significantly increasing the number of minority engineering graduates. The program was designed to motivate highly qualified minority young people to select engineering careers by providing grant-in-aid support and technically oriented job assignments with engineering and industrial firms. We intend to produce fully qualified engineers who will be thoroughly competent and able to compete successfully with graduates of UTK and other engineering schools. The Minority Engineering Program is built around and incorporates the Co-Op program in which students alternate quarters of academic work and industrial experience. The pre-Co-Op summer work experience is intended to give the young student an opportunity to obtain an early exposure to the world of industry and engineering. Sponsors provide technically oriented jobs for the student and assign an engineer or supervisor to act as the student's mentor. In a pre-Co-Op job the young students gains a practical understanding of engineering. Assignments include engineering clerk, laboratory technician, draftsperson, maintenance crew, field technician or other engineering related activity.

Other important components include: special orientation for students, involvement of parents in orientation program, employers. Spring workshop to explain minority program, close monitoring of program students academic and co-op work progress.

Charter member in Southeastern Consortium for Minorities in Engineering (SECME, which seeks to prepare 9-12 grade high school students for college science courses). We provide faculty oversight of several local high school programs.

Target Population

SECME 9-12 grades and undergraduates. High school students must be outstanding, have taken math and science courses required for admission to the College of Engineering. Black, vast majority from public school. Total 85-86: 220.

Funds

Total budget 85-86 $123,000 (all institutional). University and college industrial grants for scholarships. Students pay usual tuition fee and living expenses. No special fees charged.

Outcomes

College matriculation rate: 100% in engineering/science/math. College graduation - 65%, 60% in engin/sci/math. Attend Engineering, Business, and Liberal Arts Colleges at UT.

Evaluation

Evaluation of students co-op experiences; student grades reviewed quarterly.

UNIVERSITY OF TEXAS AT ARLINGTON

TEXAS ALLIANCE FOR MINORITIES IN ENGINEERING (TAME)

The University of Texas - Arlington sponsors the Arlington chapter of TAME, Inc. (Texas Alliance of Minorities in Engineering). TAME was created in 1975 to deal with the problem of low minority participation in the technical fields. TAME provides a strong bond between academic community and industry in their dedication to pinpointing those high school students with demonstrated proficiency in mathematics and science. Through activites like summer employment, field trips and counseling, students are able to see the importance of preparing themselves to compete for jobs in companies like IBM. TAME programs throughout the state aim to make students aware of what their area has to offer in terms of careers in industry.

TAME reaches more than 15,000 Texas students per year through such programs as:
O career conference with leading engineers
O summer jobs in sponsor companies
O summer community college scholarships
O campus, plant and NASA tours
Odirect classroom involvement by local members in the engineering fields
O development and definition of pre-engineering curricula
O personal assistance to selected public schools
O Expo - TAME's mobile trailer exhibit which takes engineering to the public.

Target Population

Students grades 8-12; black, Hispanic, Native American; total: 3,400 (not differentiated), all from public school.

Funds

External $140,000

Outcomes

Aim to encourage solid math/science course sequence in grades 8-12 so no college data.

Evaluation

Tracking system is being established.

UNIVERSITY OF TEXAS AT AUSTIN

EQUAL OPPORTUNITY IN ENGINEERING PROGRAM (EOE)

The Equal Opportunity in Engineering Program at the University of Texas at Austin, College of Engineering, was begun in 1970 to provide support for achieving a student body which represents the ethnic distribution of the college-aged population within the state. The major elements of the College's EOE Program were conceived to be:

O A healthy financial support program of industrial contributions
O An extensive retention program to minimize attrition during the first two years of college
O A vigorous recruitment program which includes extensive mailings, one-day campus visits and concentrated on-campus orientation programs
O Maintenance and increase of a strong student support organization (know as Pi Sigma Pi) which provides effective communication among minority students and between faculty and students.

The EOE Program provides recrutiment programs reaching over 1000 high school students. Retention activities include pre-freshman summer program, counseling and mentor program, a tutoring office and referral services. However, the most unique aspect of the EOE Programs may be the student organization, Pi Sigma Pi. Pi has a campus membership of about 200 students and includes chapters of the National Society of Black Engineers and the Society of Hispanic Professional Engineers. The size of this organization offers significant opportunites for staff and student communication and contact.

Recruitment efforts consist of:
O "World of Engineering" one-day major recruitment event attracting approx. 850 minority high school students, their teachers and counselors to the campus for a day of orientation and laboratory tours.
O A one week intensive orientation for 52 high school students who had completed their junior year. This program forms a part of the national effort called MITE.
O PREP high school enrichment program is a cooperative effort

between the College of Engineering and the College of Sciences and Engineering of the University of Texas at San Antonio. Under this eight-week program, approx. 300 students commuted to the UTSA campus each weekday for concentrated study in mathematics and basic engineering concepts.

Retention efforts include:
O Access to an active counseling office that intervenes when necessary with students in academic or personal difficulty
O Focus on early detection of students having difficulty
O Upper class student mentor program to support incoming students
OExpansion of special tutoring activity with emphasis on group tutoring
OSummer freshman orientation sessions using minority students to alert incoming students to factors which affect success
OPREVIEW, an intensive seven week period for 23 newly admitted freshmen, funded by a grant from the National Action Council for Minorities in Engineering. PREVIEW provides admitted freshmen with enrollment in mathematics, English, or physics in the summer prior to the fall freshman semester; special counseling, advising, tutoring; and participation in a special research project to provide more information on factors affecting retention.

Target Population

High school juniors and seniors; undergraduates; graduates sometimes serve as mentors for undergraduates; must be Hispanic, black or Native American (must be a U.S. citizen). 705, mostly from public school.

Funding

Corporate contributions, institutional funds, state and University revenues. Corporate in-kind contributions estimated at $150,000; external funds app. $261,000; institutional (financial aid) app. $864,000.

Outcomes

No data

Evaluation

Individual program elements are administratively evaluated by survey, financial assessment, tracking reports, etc. An EOE committee reviews program progress periodically.

SUMMER MINORITY PROGRAM - GEOLOGICAL SCIENCES

The Summer Minority Program in Geological Sciences at the University of Texas at Austin is a new program to begin in the summer 1986. The goal of the program is to introduce 20 minority students (Jr. and Sr. high school students) to geology and geophysics. Five days will be devoted to lectures, lab projects,

and field trips to seduce students to possibly major in geoscience in college.

One director, six faculty members and two counselors all part-time will be used.

Target Population

High school seniors and juniors; minorities from Texas; all from public school. (no numbers yet)

Funds

$10,000 from external sources.

Outcomes

No data

Evaluation

No data

UNIVERSITY OF TEXAS AT SAN ANTONIO

SAN ANTONIO PREFRESHMAN ENGINEERING PROGRAM (PREP)

Since the summer of 1979, the University of Texas at San Antonio has conducted the San Antonio Prefreshman Engineering Program. The purpose of this program has been to identify high ability middle school and high school students of the Greater San Antonio area who are potential engineers or scientists and to give these individuals needed reinforcement to successfully pursue future college engineering and science studies. Women and minority students are special target groups. Specific objectives:

O to increase the number of competently prepared students from the San Antonio area who will ultimately pursue engineering studies in college
O to reinforce the mathematics preparation of these students at high school and college levels
O to increase the retention of these students in college
O to acquaint these students with professional opportunties in engineering.

PREP makes a special effort to recruit high ability girls and minority students from grades 6-10 (since 1979, 78% have been minority and 45% girls). The PREP Program is an advanced enrichment program not remedial. Participants develop abstract reasoning skills and problem solving skills. The Program is very demanding in attention and intellectual effort. Homework, research projects, and exams are given in courses. A final grade is awared to these students. Grades are sent to the schools. The success rate is usually around 80%. These students earn a

passing grade from this program and realize that through hard work and sacrifice they can negotiate studies successfully in a college setting. In the summer of 1986, four new PREP Programs will be started in Texas (TexPREP) with a grant from the Texas Coordinatring Board to partially support starting costs.

Part of the program effort is directed toward the reinforcement of the normal precollege mathematics instructional program by discussing college level topics not offered in high school or middle school. The science and engineering awareness thrust is given in the engineering courses, research and study sessions, and career opportunities components. Courses include logic, algebraic structures, introduction to engineering, introduction to computer science, topics in problem solving, research and study, career opportunities and awareness.

Target Population

Students grades 6-10; Hispanic, Asian American, black, Native American (300), most from public school, some from Catholic school. Requirements: B or better current academic average (6th or 7th graders must have an A in math and in english or science); two recommendations from teachers; essay; appropriate math achievement for grade level.

Funding

Total 85-86 budget $30,000 institutional with approx. $210,000 in kind.

Outcomes

Since 1979, 1200 students have completed at least one summer of PREP; of that number 398 are eligible for college; 326 of these responded to a survey last summer: 255 are in college (78%) - 139 in engineering, 40 in science, 76 in math. 32 graduated - 15 in engineering, 12 science and 5 other. Over 88% of college eligible students attend college or have graduated.

Evaluation

One is usually given in 7th week of program. A yearly follow-up is mailed to former participants to track their progress. Final Report.

UNION COUNTY COLLEGE

PRE-COLLEGE ENGINEERING PROGRAM FOR MINORITIES

Union County College conducts a Minorities in Engineering Program designed to prepared young people from minority groups for careers in engineering. Working with young people in grades seven through twelve, the Program aims to assure that the students are motivated and guided toward careers in engineering,

are taking appropriate preparatory courses for further study in engineering at the college level and are participating in supplementary studies in mathematics, science and communications skills - all with a special engineering slant. The program also focuses on special motivational, counseling and tutorial services for Union County College minority students interested in careers in engineering.

The National Minorities in Engineering (MiE) effort, of which Union County College's MiE program is an integral part, is designed to utilize all the resources available to improve the educational approach and curriculum articulation. Most importantly, it works to establish an atmosphere which nurtures the intellectual nature of all people and opens up the opportunity for every individual to pursue his/her own goals in life. MiE strive to present people with choices; choices which result from intense expansion of the mind. Only after an individual has acquired knowledge and has become aware of the many options available, is he or she able to truly choose a direction.

Through a cooperative effort with four Union County school districts a program was implemented within the districts' normal school structure. It involved using college prepared learning materials, alternative teaching methods, counseling and monitoring of the activities by the College.

The MiE program has been successful in increasing the number of minority students and now is looking to reach out to other minority communities; to focus particularly on the Puerto Rican community. A college level program is being prepared.

Target Population

Students grades 7-12; mostly black, some Hispanic, Native Americans, Asian American; all from public school (total 412), (some white). Requirements: minimum basic skills, grades.

Funds

Total approx. $66,000 from private industry, federal and state grants. Schools provide support in kind.

Outcomes

College matriculation rate: 90%; 60% in engineering/science/math.

Evaluation

We send a program evaluation to teachers and ask them to give us honest criticism of the curriculum and its effectiveness. Questionnaires are also sent to students for their reaction to the program.

APPENDIX B

Members of the Advisory Panel to the Engineering Education for Minority Students Study

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